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THE NATIONAL ACADEMY OF SCIENCES

ADDRESS OF THE PRESIDENT¹

By Dr. W. W. CAMPBELL

DIRECTOR EMERITUS OF LICK OBSERVATORY AND PRESIDENT EMERITUS OF THE UNIVERSITY OF CALIFORNIA

Not many times in a century does an existing condition receive wider recognition than has the present-day fact that up and down upon the earth, men, women and children are suffering in unaccustomed numbers; and we should realize that their sufferings are very far from being exclusively physical in character. In some degree, certainly, "the time is out of joint," and all who were "born to set it right," and who shall achieve high degrees of success in their endeavors, will be regarded as benefactors of the human race. Everybody who observes and thinks and draws inferences can mention a few methods or policies which, if adopted and applied, might help a bit. I myself wonder what would happen, for example, if the American styles in high custom-house tariffs, now be-

come the fashion in so many nations, could be moderated to let the seven seas, covering three fourths of the earth's surface, be used again for international commerce; and so on through a long list of pertinent items which, by the way, seem to lie largely, perhaps entirely, within the domain of the economists and the social scientists. However, there are those who say publicly, but without inclination to be specific, that discoveries in the physical and biological sciences have been coming too rapidly for the good of the world. Such ideas are now two or three years old, but they are not "sleeping dogs," and there are still some things to be said in comment.

I assume that even the very small group of extremists who advocated the taking of a holiday in scientific research would not like to call off the scores of able and devoted investigators in medical science who

¹ Given at the dinner of the Academy in Cleveland, Ohio, on November 21.

are seeking the cause and preventive of cancer, the cause and preventive of infantile paralysis or the cause and preventive of the common cold, not to mention other scourges of mankind.

I wonder: does the holiday group think that Einstein's theory of relativity, with its profound influence upon the development of the physical sciences, has taken any laborer's job away from him?

"Man shall not live by bread alone." Has the building of great telescopes and expensive observatories and their use in studying the sun, the moon, the comets, the planets, the stars and the nebulae subtracted from any man's material welfare or from his joy of living?

Does any one in his senses want to halt or discourage the almost countless students of the atom, its structure and its ways?

Can we go out and find any upstanding young man who is ready to say that research in aerodynamics and other elements of the aviation problem, now so extensively and intensively conducted, should cease?

The tendency to place the blame for the ills of the world upon research in the sciences is due chiefly to a failure to comprehend the nature of scientific discovery. The critic is inclined to confuse discoveries in pure science with the applications of those discoveries to the affairs of the manufacturing and commercial world or to the winning of victories in war. The man in the street, and even the school teacher, the clergyman, the lawyer, and the intellectuals in all walks of life, frequently think of a scientific discovery as if it were an actual creation; as if it were something entirely new; something that did not exist up to that time. They think of new knowledge as new truth, and they are wrong; it is old truth. In general, the truth discovered through research is truth which has existed through the ages. The investigator has merely uncovered it and brought it to the attention of his colleagues and their fellow citizens. The mining prospector in the mountains who is so fortunate as to discover gold, that is, uncover gold, does not create that gold, does not even discover new gold, but he uncovers gold that is at least as old as the hills themselves; and such is precisely the case with the discovery of the truth about our surroundings.

The observations made by men of science in the last three centuries and the experiences of the human race have given us no valid reason to doubt the correctness of the thesis that every particle of "matter" in the universe—using the word matter in the older and popular sense—is endowed with the property and the necessity of obeying the fundamental laws of nature. Our universe of stars and other celestial objects, including our own star and our own earth and all its parts, has been evolving through long ages,

up to its present state, under the guidance and compulsion and control of what, in my opinion, will eventually prove to be perfectly definite and relatively simple laws. We have no reason to suppose that these laws are ever capricious or undependable. In fact, the arbitrary and the capricious do not seem to exist in physical nature. Whether the arbitrary and the capricious exist in human nature is quite another matter; but that is a bridge we need not cross this evening!

The great planet upon which we live is responding to the forces, to the laws, which have controlled its evolution and will control its further evolution, save as to the occasional and puny efforts of man and other animals in opposition thereto. There is nothing of greater importance to the human race than that its universities and its other research institutions should determine the natures and the potencies of those forces and the ways of those laws so that the plans of man for doing the work of the world may be in harmony with them, and not in opposition to them; so that his modes of thought, his understanding of his environment, his reverence for the truth may be developed upon a firm basis. The more thoroughly we succeed in placing ourselves in harmony with our surroundings on the earth, in both the practical and the idealistic affairs of life, the better shall we succeed in marching with the evolutionary current that is always ready to serve us by joining forces with us.

It is true that many discoveries made in the domain of the sciences represented by members of the National Academy could be used to the injury, or at least to the disadvantage, of human society. A knowledge of bacteriology, of the ways of the bacilli of this or that infectious disease, has been of priceless value to the peoples of the world; and the possibility, or the threat, that such knowledge will be used in time of war to kill the men, women and children of an enemy nation is not sufficient reason why further advances in bacteriology should be discouraged.

That the *too-rapid* introduction of labor-saving machinery and of the electric control of machinery from central switchboards, say in the middle and later 'twenties, when the industries (all except farming) were booming, had a serious bearing upon labor unemployment, can not be denied; but is that a good and sufficient reason why the further study of electricity or of any of the forces or phenomena of nature should be discontinued? Many devotees of the pure sciences, including several members of the National Academy, have ably maintained the thesis that advances of knowledge in the fields of the various sciences have been accompanied by the development

of new industries giving employment to great numbers of men, perhaps more men than have been simultaneously displaced by new labor-saving devices in the older industries. However, the time may come when governments will endeavor to regulate, not the discovery of knowledge in the domain of the sciences, nor the speed of discovery, but the applications of new or old knowledge, in the form of mechanical inventions or new methods, to the work of the world, in order that labor would have time to adjust itself to conditions which governments may think are changing too rapidly. Quite likely the governments of the nations will attempt, by international agreements, to prevent the killing of enemy peoples by microbes, by poisonous gases, by giant bombs dropped out of the blue sky. Some of the agreements or treaties on the subject might prove to be "mere scraps of paper."

Even so, we could wisely recall that the present-day use of automobiles by kidnappers and other inhumans does not even suggest to any of us that no more automobiles be made. Realizing that all such problems of attempted control by government would have to deal with human beings and human nature, one is impelled to hope that the guidance of the economists and the social scientists would be found ready and equal to the extremely difficult occasion, in case of call.

I have confidence that all thoughtful persons, including the young men and the young women who, spiritually at least, are the most tragic sufferers from the ill economic winds which have been blowing throughout the world, will join us in saying that the Golden Age of mankind is in the future and not in the past.

PRESENTATION OF THE MARY CLARK THOMPSON MEDAL¹

By Dr. DAVID WHITE

SENIOR GEOLOGIST OF THE U. S. GEOLOGICAL SURVEY

FULFILLING the unanimous recommendation of the committee, you are to-night bestowing the accolade of tribute to distinguished service in geology and paleontology on a member of the academy whose first collegiate experience was that of professor and whose first scholastic investiture was that of master of arts, in honor, at Yale University.

In common with many boys in Cincinnati, Schuchert began at an early age (12) to collect the abundant Ordovician invertebrate fossils which public improvements had made accessible in many new quarries and exposures; but his matriculation in paleontology as a profession was delayed until he was 17, when he became a paid assistant to E. O. Ulrich, then curator of geology at the Cincinnati Society of Natural History, and now also a Mary Clark Thompson medalist of the academy. Four years afterward he was called, together with his collections, to assist James Hall at Albany, who was preparing an "Introduction to the Study of the Genera of Paleozoic Brachiopoda." Next he worked at the Peabody Museum with Beecher, who was studying the ontogeny of the same great class, in which Schuchert had long been deeply interested.

In 1893 Schuchert went to the Geological Survey and the National Museum in Washington as assistant and understudy to Walcott on the invertebrates of the older Paleozoic. There he took part in Walcott's great monograph on the Cambrian Brachiopoda, be-

sides sharing in the excitement of working out the Cambrian Medusae.

Where could a student have found more satisfying courses in Paleozoic paleontology than under Ulrich, Hall and Clark, Beecher and Walcott?

While in Washington Schuchert completed his "Catalogue of Brachiopod Genera and Species"¹ and inaugurated the present admirable plan of cataloguing, arranging and exhibiting the invertebrate fossils, of which he was curator, in the National Museum. This work is a model followed by many other institutions.

To Schuchert the ancient world is a ceaselessly shifting landscape, alive with constantly changing and evolving animals and plants. Accordingly, the appeal of paleogeography to his vivid paleontological realism was as natural as it was fortunate. Paleogeography treats of the succession of geographies of geologic times. It gives orientation to geological history and sets a background to the history of life. It is a most fascinating and stimulating task, which, nevertheless, few geologists have the courage to undertake and still fewer to print their products—which is probably well.

Starting with shore lines definitely determined at a number of points—with feet on the ground, so to speak—the paleogeographer proceeds to trace his coasts, mountain regions and principal basins and streams through points less well located, and on to points less probable, and, finally, through points

¹ At the dinner of the Academy in Cleveland.

¹ U. S. Geol. Surv., Bull. 87, 1897.

based on conjecture or mere guesses weighted by his best judgment. He must take into account the causes of present geography, the relations, composition and migrational distribution of the extinct land and sea faunas and floras and the indicated land connections; the characters and sources of the sediments; the climates, continental warping in conjunction with progressive invasions and recessions of the sea; tectonic trends and transgressive folding. It calls for the systematic examination and orientation of all the existing information of all sorts and geological insight, together with a restrained imagination, in its evaluation.

Since 1905 Dr. Schuchert has published over 50 different paleogeographic maps, and he now has on his desk about 125 maps on which he is plating new matter or is correcting, revising and confirming previous work as new data come to his hand. This is a monumental work, more than has ever been done in this field by any other man, and—what is better—it is highest in scope, reliability and detail.

Largely from Schuchert's indefatigable paleogeographic researches have emerged the learning, the perspective and the analytical philosophy which characterize both his short papers, which cover a wide range of subjects, and his text-book writings. In scholarly form they impregnate his work as associate editor of the *American Journal of Science*, and as reviewer and commentator.

Meanwhile Schuchert's most important contribution to paleontology, a memoir by Schuchert and Cooper, revising the genera of the brachiopod sub-orders Orthoidea and Pentamerioidea, was published in 1932. The classification there presented is followed by most paleontologists at home and abroad.

In conclusion, the committee ventures to add its wishes that Dr. Schuchert may live many years to continue his valuable labors and to enjoy in contentment the triumphs of his students and followers who have caught the fire of his zeal and his realistic conceptions of the panoramic life of the ancient past and its relations and reactions to an incredibly complicated geological history.

RESPONSE BY PROFESSOR CHARLES SCHUCHERT

SOME months since, when I was informed that I was to be awarded the Mary Clark Thompson Medal, the greatest honor, next to election to this academy, that can come to an American geologist, I was not only most agreeably surprised, but as well immensely pleased. And now this pleasure is still further increased by the remarks of the chairman of the committee of award, and especially, if I may say so, by his evaluation of my results in paleogeography.

When the good news of this award came to me, two remarks made by my parents long ago flashed through my mind. One Sunday evening, when I came home from an afternoon's hunt for fossils on the hills of Cincinnati, my shoes covered with the sacred soil in which the fossils had been entombed, my dear mother's greeting to me was: "You bring more dirt into the house than your rocks are worth." And on several other occasions my father remarked: "Charlie, if you would only pay as much attention to furniture making as you do to the collecting of fossils, you would become a rich man!" However, it was from such days of communing with nature and her fossilized creations that I was learning her ways of genesis, and if my parents are looking down on me to-night, perhaps they will agree that those golden Sundays were not wasted, after all.

I got my first fossil when I was seven or eight years old. As I stood watching a gang of men digging a trench near my home, one of the Irish laborers threw a bit of rock up to me with "Here, Johnny, here's something for you." For some years this curiously shaped piece of rock remained a what-is-it, since no one about me could tell me what it represented. My father had read a little in Von Humboldt's *Ansichten der Natur*, and he thought it might be a *Versteinerung*, a petrification, but what kind of a living thing it once was, he had not the slightest notion. A year later, father brought me another fossil given him by a friend who lived near a limestone quarry, but this, too, long remained just another what-is-it.

In those youthful days, I very much wanted to own a goat—not a billy with long horns such as I had made unfortunate acquaintance with, but one of the gentler sex. The young nanny-goats that I coveted had, I noticed, very small horns with blunt ends, which reminded me of the fossil the immortal Irishman had tossed up to me. Also, their split hoofs looked like the second fossil in my collection. So, since any well-ordered cabinet must have labels, I wrote out two: one read, "The petrification of a nanny-goat's horn," and the other, "The petrification of a nanny-goat's hoof." Thus, you see, even if my mother could not buy a live nanny-goat for me, as an embryo paleontologist I set to work to get together a petrified one! In the sequel, however, I found that one of my fossils was a coral and the other a bivalve shell.

Such were my beginnings in paleontology, in the days when most geologists had not yet taken kindly to the theory of organic evolution, when many believed with Bishop Ussher that the earth had been created in a week, 4,004 years before Christ, and that the long geologic record could be made to agree with

the seven days of Genesis. Since then I have labored professionally with geologists for nearly fifty years, have seen the geologic column—the geologist's yardstick—lengthen sixfold, have read of tens of thousands of new species of fossil plants and animals added to our knowledge and have witnessed the pushing backward in time of the origin of the earth from six thousand years to something like two billion. Truly, time and organic creations are without end!

When I became an active collector of fossils, I knew of no public geological museums, and now our country has a great number, and of these a half dozen or so are rated among the best in the world. Then, but few states had geological surveys, and the Federal Government none that was permanent. Today, nearly all the states have such, and the government as well, and they are of immense service to the people in economic and theoretic ways. Then, there was no general geological society, and now there are

several, two of them having a combined membership of upward of 3,000, of whom two thirds are in search of profitable rocks—those containing oil, coal and ores—and the remainder are teachers of geology and research workers. And the oldest of these geological societies now has an endowment of four million dollars, given to it by one of its fellows.

We are now living in the transition period into the age of science, and if humanity continues to apply what science provides, the day will come when no one will need to work more than the decreed thirty hours a week. No one, that is, except the research workers!

In retrospect, I am indeed grateful to that unknown Irishman who threw me my first fossil, since it was the first step in the path that led to this evening's event. Mr. President, I thank the academy, the committee of award and you for the great honor conferred upon me by the award of the Mary Clark Thompson Medal.

VARIATION AND EVOLUTION AMONG THE STARS¹

By Dr. HARLOW SHAPLEY

HARVARD COLLEGE OBSERVATORY

(1) Variation and evolution are defined. In cosmic problems, the short life of the observer, or even of his civilization, compared with the time of major changes, makes it necessary to infer evolutionary tendencies rather than observe them. Variety in types of objects is an indication of past developments. Theories of stellar evolution are based on studies of variation and varieties.

(2) The clearest direct evidence that stars change and that the universe evolves is in the simple fact that sun and stars shine; for we now know that outgoing radiation is outgoing mass and that a hot radiating body in cold space decreases steadily in material content because of its inevitable radiation. Because it shines, it must change steadily also in temperature, in density, in mass, in all its physical properties. A globular star cluster, for instance, loses through its radiation into empty space a million million tons of matter every second—a loss that not only spells evolution for its thousands of stars, but alters the gravitational structure of the cluster itself.

(3) The varieties of galaxies and the variations in their positions and velocities are direct evidence of the evolution of the whole universe, and are the bases of the expanding universe interpretation. The probability is high that the red shift in the spectra of galaxies indicates an expansion, and the rate is about

one hundred miles a second for every million light years of distance.

(4) The variations that most concern astronomers are the changes in the light of stars. The changes are of three sorts: (a) Periodic variations that perhaps do not directly indicate evolution because of the recurrence indefinitely of the same conditions; (b) irregular variations that have little rhyme or reason; (c) progressive alterations.

(5) The most observed star in the sky during the past several months has been the fourth magnitude (naked eye) eclipsing double star, Zeta Aurigae. A recent study at Harvard, based on about three thousand photographs, gives a history of this thousand-day variable for the past forty years. An eclipse of the sun lasts, at the most, seven minutes; but the total eclipse of Zeta Aurigae persists for thirty days. The double is remarkable in that the masses and luminosities of the two companions are equal, but the volume of the red giant component is thirty thousand times that of its hot, blue associate.

(6) The first results obtained with two large new reflecting telescopes are presented at this time; both instruments have been set in operation during the past year. With the 61-inch Wyeth telescope at the Oak Ridge Station of the Harvard Observatory, Dr. W. A. Calder has measured photo-electrically the variations of an important eclipsing binary, η Herculis, and from his work it is found that the orbit is

¹ Abstract of a popular illustrated lecture for the citizens of Cleveland, November 19.

twisting in space. With the 60-inch reflector at the Bloemfontein Station of the Harvard Observatory, Dr. Paraskevopoulos has photographed in red light the giant gaseous nebula, 30 Doradus, in the Large Cloud of Magellan. From photographs with this instrument it now appears that this famous nebula, sometimes called The Tarantula, has in its center a rich cluster of supergiant stars, each ten or twenty thousand times the luminosity of the sun.

(7) Announcement is made of the discovery in our own galaxy of about seven hundred new variable stars, the study of which contributes slowly to our increasing knowledge of galactic dimensions as well as to the central problem of the evolution of stars and of the stellar universe.

(8) In the nearest of external galaxies, the Large Cloud of Magellan, periods of pulsation have been measured on Harvard plates for many of the supergiant variables of the Cepheid class. These stars are important in the improvement of the period-luminosity law, which is fundamental in the measurement of the distances of galaxies.

(9) In the Small Cloud of Magellan, which is also a relatively near external galaxy, a thousand new variable stars have been found within the past few months through an examination of new photographs made at the Bloemfontein Station of the observatory.

(10) An indication of development throughout the Metagalaxy is found in the peculiarities of the distribution of galaxies throughout the enormous spaces covered by the surveys carried on at Mount Wilson and at Harvard. The Harvard census of new faint galaxies has now gone beyond 125,000. About a third of the sky has been covered in this survey; the discovered irregularities prove important for considerations of expanding regions, collapsing regions and places where the Metagalactic developments appear to be at a standstill. One of these apparently non-expanding regions is the Twin Supergalaxies in Hercules, a double group that contains several hundred individual galaxies, and extends over a region more than three million light years in diameter at a distance from the sun of about a hundred million light years.

ABSTRACTS OF PAPERS PRESENTED AT THE AUTUMN MEETING OF THE NATIONAL ACADEMY OF SCIENCES¹

An x-ray study of grain-growth in metals produced by heat treatment: CHRISTIAN NUSBAUM (introduced by Dayton C. Miller).

The measurement of the absorption coefficients of x-rays of very short wave-length: F. K. RICHTMYER, T. R. CUYKENDALL and M. T. JONES. Almost no measurements have been previously made of the absorption of monochromatic x-rays of wave-length less than 100 x-units. The present program of investigation was undertaken in order to obtain such measurements, partly because of their importance in connection with current theories of physics; partly because such data are needed in high-voltage roentgenology. The high-voltage generating plant is capable of producing 600 K.V. The two-crystal spectrometer is of the direct-reading type, the x-rays passing through the crystals and being reflected from internal planes, instead of from crystal surfaces, as is usual at longer wave-lengths. A resolving power of 30 at 50 x.u. and of 160 at 200 x.u. is obtained. The ionization chamber contains argon at a pressure of 80 atmospheres. The ionization current is amplified by an FP54 tube. Measurements are now being made on various elements in the wave-length range $30 < \lambda < 150$ x-units with a precision of the order of 1 to 2 per cent. Sample data on the mass absorption coefficient, μ/ρ for carbon and for lead, are as follows:

	Wave-length	μ/ρ
Carbon	100 x.u.	0.142
	60	0.121
Lead	30	0.22
	60	0.90
	100	3.30
	135	7.15
	145	2.03

Evaporated surfaces on gratings for the vacuum ultra-violet: R. C. GIBBS and H. M. O'BRYAN (introduced by Ernest Merritt). On account of the greater permanence of its reflecting power, the glass grating has found general acceptance over the speculum metal grating for spectral studies involving wave-lengths less than 2,000 Å. However, the reflecting power of glass is small for wave-lengths less than 1,000 Å and falls to less than 1 per cent. below 400 Å. Recent progress in the technique of preparing evaporated metal surfaces has made it possible to apply these metal films to already ruled glass gratings without loss of definition in the spectral lines. By suitably choosing the metal for the desired spectral region a greatly increased reflecting power of considerable permanence can be secured, thus reducing the time of exposure several fold. In most cases these films can be removed by chemical treatment without injury to the quality of the grating, thus making it possible readily to renew the surface with a film of the same or another metal. For stability and permanence of reflecting power

¹ Cleveland, November 19, 20 and 21.

platinum has been found to be most generally satisfactory over an extended spectral region. A fresh aluminum film yields a greater reflecting power than platinum for the longer wave-lengths in this region but shows a marked falling off in its reflecting quality with use, especially in the presence of moisture. No such effect is observed for aluminum in the visible or near ultraviolet regions. At 500 Å platinum has a reflecting power about 10 times that of glass. For various reasons it was found advantageous first to apply a thin film of chromium to the grating before depositing the platinum. Other metals, such as chromium, germanium, tungsten and palladium, as well as antimony sulfide, were found to be useful for certain spectral regions.

A special theory of cathode sputtering: EDWARD S. LAMAR and KARL T. COMPTON. It has long been known that metals disintegrate under the influence of bombardment by fast-moving positive ions. This was first noted at the cathodes of gaseous discharge tubes and the process is commonly known as "cathode sputtering." Two principal theories have been advanced to account for this disintegration: one, that it is thermal evaporation from the regions of local high temperature produced by the impinging ions in the brief interval before this energy is dissipated into the body of the metal through thermal conductive processes. The other theory ascribes the sputtering to the mechanical "bumping off" of surface atoms by ions which have penetrated below the surface and rebounded so as to transfer a part of their outward momentum to the surface atoms which they strike from behind. Langmuir has shown that the latter process is consistent with the minimum kinetic energy with which impinging ions will produce sputtering in the case of several gases and metals. Others, and I believe Langmuir also, believe that the former process may be the predominating influence in many cases. Our earlier work on the "accommodation coefficient" of ions impinging on metal surfaces has thrown light on the conditions of energy and momentum transfer at impact. This work has also given evidence that small, light ions, such as hydrogen and helium, are far more likely to penetrate the surface of the metal and deliver energy and momentum to underlying metallic atoms than are the larger and heavier ions. This observation immediately suggests that the "bumping off" process may predominate in the sputtering of metals by small ions, and the evaporation process may predominate in the case of large ions. The present paper is an attempt to extend Langmuir's original theory, which predicted the minimum energies required for sputtering, so as to account also for the rate of sputtering produced by small ions on their rebound from metallic atoms lying below the surface. To make this calculation, three quantities need to be known: First, the mean free path of the ion as it penetrates the metal previous to its first collision with an atom; second, the average normal component of the mean free path of this ion as it moves back toward the surface after its first collision; and third, the law of angular scattering and momentum transfer at a collision. Our previous work has shown that, for high-speed ions

of the type here considered, the third function is represented with considerable accuracy by the laws of impact between elastic spheres. There is some experimental evidence regarding the first two quantities which may at any rate be given values of the right order of magnitude by making the assumption that here again the collision processes are, to a first approximation, those between elastic spheres. In terms of these quantities, a calculation is made of the number of surface atoms in the metal which are struck from behind by ions coming after one or more collisions from the various layers of atoms beneath the surface, and imparting to the surface atom an outward momentum sufficient to overcome its attachment to the surface as expressed by its atomic heat of evaporation. This calculation has made possible the setting, with some confidence, of upper and lower limits to the rate of evaporation of a metal bombarded by any given number of penetrating ions. Within these limits the theory permits an estimate of the actual rate of sputtering with a somewhat less degree of certainty. The calculated values appear to be reasonable, but no existing experimental data have been secured under sufficiently well-controlled conditions to permit of an actual comparison between theoretically predicted and experimentally observed rates of sputtering.

Measurement of the velocity of light in a partial vacuum: A. A. MICHELSON, F. G. PEASE and F. PEARSON. To be published later.

The temperature of the copper arc: C. G. SUITS (introduced by Albert W. Hull). New measurements of the velocity of sound in the copper arc (6 amperes) in air at atmospheric pressure have yielded velocities somewhat higher than the preliminary values previously reported (*Phys. Rev.*, 46, 339, 1934). The new velocities are 1.42×10^5 cms sec.⁻¹ for arcs up to 8 cms in length, decreasing to 1.36×10^5 cms sec.⁻¹ for arcs of 15 cms length. The temperatures, uncorrected for dissociation, are 5,000° K. and 4,600° K., respectively. When account is taken of the dissociation of the oxygen, which is nearly complete, the partial dissociation of the nitrogen (3 per cent.) and the change in specific heat with excitation, the corrected temperatures are found to be 4,200° K. and 4,000° K. For an arc temperature of 4,000° K., the electron density n_1 in the arc may be calculated from the observed gradient of 16.5 volts cms⁻¹ and current density of 10 amperes cms⁻² by assuming all the current to be carried by electrons. The kinetic theory value of mobility at the observed temperature is used. A second value of current density n_{II} may be calculated from the thermal ionization equilibrium equation. To bring n_{II} into agreement with n_1 it is necessary to assume a partial pressure of copper vapor of 7.5×10^{-5} atmospheres.

A new isotope of nitrogen, artificial radioactivity and the emission of gamma-rays which accompanies the disintegration by capture of atomic nuclei: WILLIAM D. HARKINS. With the collaboration of D. M. Gans and H. W. Newson a new isotope of nitrogen of mass 16 has been discovered. It was assumed that this nucleus would be unstable, so that it would exhibit the phenomenon of

induced radioactivity, and would disintegrate, with the emission of a negative electron, and change into the nucleus of an atom of oxygen of mass 16. This is the ordinary oxygen of the atmosphere. This has been confirmed by Fermi. Neutrons of extremely high velocity, 35,000 miles per second, have been found, and have been shown to give rise to gamma-rays, analogous to those emitted by ordinary radioactive substances, but seemingly of much higher energy. Thus this energy rises as high as twelve million electron volts when nitrogen is converted into boron and helium by the action of neutrons. Contrary to what has been heretofore believed, it is found that atomic nuclei have in no case been disintegrated unless the high-speed projectile which causes the disintegration is captured by the nucleus which it hits. In this sense the synthesis or building of an atomic nucleus is a much more fundamental process than its disintegration. It is found that the gamma-rays emitted during such a disintegrative synthesis excited by neutron bombardment increase rapidly in energy as the energy of the neutron increases. An interesting feature of all the disintegrations thus far effected is that during the process kinetic energy always disappears (or very rarely is conserved) but never increases. The atomic nucleus is found to be a remarkably efficient machine for the conversion of kinetic into gamma-ray energy.

Biographical memoir of Edward Bennett Rosa: W. W. COBLENTZ.

Biographical memoir of Thomas Corwin Mendenhall: HENRY CREW.

Biographical memoir of Ernest Julius Wilczinski: ERNEST P. LANE.

On the equivalence of quadrics in m -affine n -space and its relation to the equivalence of $2m$ -pole networks: RICHARD STEVENS BURINGTON (introduced by Arthur B. Coble). The work of Cauer (*Göttinger Nachrichten*, 1934) and others on the equivalence of $2m$ -pole electrical networks indicates the importance of the matrix study of quadratic forms under m -affine non-singular transforma-

tions, $x_i = x'_i$, $i = 1, \dots, m$; $x_j = \sum_{k=1}^n t_{jk} \cdot x'_k$, $j = m+1, \dots, n$,

of matrix T . Two symmetric matrices, A and B , are said to be m -affine congruent if there exists a T such that $A = T' \cdot B \cdot T$. The elements of A , B and T are assumed to belong to a field. It is shown that matrix H , where H is A with rows $r_1 \dots r_t$ and columns $s_1 \dots s_t$ deleted ($r_i, s_i \leq m$), is an invariant matrix of A under T ; that is, \bar{H} can be found (i) either by transforming and then deleting the rows $r_1 \dots r_t$ and columns $s_1 \dots s_t$, or (ii) by deleting the rows and columns indicated, in A and T , and then transforming. The determinants $d(H)$ are relative invariants, their various ratios absolute invariants (parameters) and the ranks of the various H 's integer invariants. If the field is ordered, the signatures are integer invariants. Every matrix A can be reduced to one of the canonical forms C_1, C_2, \dots indicated, according to the ranks (and signatures if the field is ordered) of

the invariant matrices of A . A necessary and sufficient condition for the m -affine congruence of two matrices, whose elements belong to an algebraically closed (real) field, is that their invariant matrices have the same ranks (and signatures) and that their parameters, in case they appear in form C_i under consideration, be identical. Two quadratic forms are m -affine equivalent if and only if their matrices are m -affine congruent in the field. A detailed reduction is given for the $m=2$ (four-pole) case; $m=0$ yields the projective theory; $m=1$, the affine case. (R. S. Burington, *American Math. Monthly*, xxxix: 527-532, 1932; *Phys. Rev.*, 45: 429, March 15, 1934). The relation of this work with that of Cauer is discussed. It is believed that this study will not only be of interest from a mathematical point of view, but that it will also throw more light upon the theory of linear networks.

On certain types of hexagons: J. R. MUSSELMAN (introduced by Arthur B. Coble). The expression

$V_1 = \sum_{k=0}^{n-1} \epsilon_k \chi_k$, where ϵ is a primitive n -th root of unity,

was introduced by Lagrange in his memoirs, published in 1769, devoted to the fundamental principles of the solution of the cubic and quartic equations. However, their entrance into the field of geometry is very recent. If we think of the χ_k ($k=0, 1, \dots, n-1$) as complex numbers representing n points in the plane, then $V_1=0$ for $n=3$ is an equilateral triangle and for $n=4$ is a pseudosquare. The writer has discussed previously two geometrical figures in which the general n -gon $V_1=0$ will arise. Since under homologies the $n-1$ Lagrange resolvents of an n -point form a complete system of relative invariants, they are used in this paper to study some hexagons connected with the figure of any triangle and its Fermat points. Secondly, the hexagon for which the Lagrange resolvents V_1 and V_2 vanish is discussed in some detail; as it is through the intermediation of a symmetrical hexagon of this type that the writer shows that associated with every positively-ordered six-point is a rectangular hyperbola. Just as for an ordered four-point there are two circumscribed squares whose vertices lie obviously on circles, so for an ordered six-point there are two circumscribed hexagons whose opposite sides are parallel and whose six vertices lie on a rectangular hyperbola.

Investigations of variable stars: HARLOW SHAPLEY. A large proportion of the research work at the Harvard Observatory bears on the numerous problems of variable stars. It is recognized that such stars stand first in importance in measurement of the universe and in the analysis of stellar evolution. Seven special researches will be summarized. (1) One of the first investigations completed with the new 61-inch reflecting telescope at the Oak Ridge Station of the Harvard Observatory has been the determination with a photo-electric photometer by Dr. W. A. Calder of the light curve of the important eclipsing system of α Herculis. The high accuracy of the work permits a study of changes in the light curve during the past few years, especially in the shift of the second

dary minimum, which indicates the motion of a somewhat elongated orbit in space. Dr. Calder's observations have permitted a redetermination of orbital elements. (2) A study, extending over several years, of those eclipsing binaries that show evidence of rotating elliptical orbits gives fuller results than heretofore available in this interesting and important phase of the evolution of binary systems. With the assistance of Miss Henrietta Swope several thousand observations have been obtained from the Harvard plates on half a dozen of these relatively rare binaries. The results show the high concentration of matter in the centers of these stars. (3) The complex, very peculiar variable star, R Aquarii, has been studied throughout the interval of nearly fifty years for which the Observatory now has systematic series of photographs. The observations give a fairly full history of the amplitude of variation of this system, which appears to consist of a long period red variable and a hot blue companion that is possibly a planetary nebula. The work is done in cooperation with Dr. Merrill's spectroscopic analyses at Mt. Wilson. (4) Two hundred and eighty new variable stars have been found and studied in several fields in the southern Milky Way in the course of the Harvard systematic survey over the whole sky. Material is now available for an examination of the distribution of period-length among long period variable stars; these faint new long period variables are found to be speedier, on the average, than brighter variables of the same class—about 240 days against 280 days. (5) A study of faint variable stars, mostly of the eclipsing type and Cepheid type, in latitudes far from the Milky Way has contributed useful data in estimating the diameter of the Milky Way system. A large number of new variable stars have been found in the course of this work, and a new long-term program of variable star study has been inaugurated. The preliminary results indicate a thickness of the Milky Way not less than 20 kiloparsecs (65,000 light years), but the population is very scarce at such great distances from the plane. It appears possible that our own galaxy, like the Andromeda system, may be nearly spherical in form when the outlying variables and other stars are taken into account, although the main body of stars in each system forms a highly flattened discoid. (6) To gain further knowledge of super-giant stars we have continued the study of brighter Cepheids in the two nearest external galaxies—the Clouds of Magellan. The periods and light curves have been determined for about fifty stars in the Large Cloud, all of absolute magnitude -1.0 or brighter. These periods furnish a check on the period-luminosity curve, both in its brighter portion and also for the faintest Cepheids. Light curves have been derived for a few of those remarkable and rare Cepheid variables with periods greater than forty days (luminosities 1,500 times that of the sun). (7) Supplementing earlier investigations at the Harvard Observatory, we have now used a series of new plates of the South African Station in the discovery of variable stars in the Small Cloud of Magellan. Six hundred new variables were added a year ago to those already known for the Large Magellanic Cloud, and now in the Small Cloud approximately one thousand have been found to

supplement the 900 previously known in that system. Probably more than 90 per cent. of the 3,200 variable stars now known in both clouds belong to the Cepheid class, and the study of their distribution throughout the systems should help in the interpretation of the gravitational organization of the galaxy.

Energy spectrum measurements of the hotter stars: C. G. ABBOT. Author recalled that in 1922, 1923 and 1928 he had observed the spectra of a few of the stars in the constant temperature room of the 100-inch telescope at Mount Wilson Observatory which was used for the purpose in the coudé manner. In the experiments of 1928 a special radiometer was constructed using vanes of fragments of house flies' wings and an atmosphere of low pressure hydrogen. The measurements were mainly confined to the cooler stars as the wide dispersion of prisms, the diminished reflectivity of mirrors and other causes combined to weaken the spectra of the hotter stars intrinsically strongest in the ultra-violet. Development of Christiansen filters for use in the division of radiation and organisms of the Smithsonian Institution suggested using a battery of them for the stellar energy spectrum measurements, each selecting a narrow wave-length region within the range 3,300 to 10,000 angstroms. Author is indebted to Messrs. E. D. McAlister, L. B. Clark and A. N. Finn for their preparation. It was hoped to use with this outfit a thermoelectric equipment which had been employed by Pettit and Nicholson for measuring the total heat of the stars, but this apparatus had been dismantled. Fortunately, Dr. Joel Stebbins consented to cooperate with his photoelectric cell apparatus. Observations made on September 2 and 3, 1934, at the coudé focus of the 100-inch telescope on Mount Wilson included a program of 19 stars beside the sun, about equally divided in numbers between types O, B, A, F and G. The photoelectric cell was used between wave-lengths 3,300 and 6,400, but was relatively very weak for the shorter and the longer wave-lengths within this range. While the observations are, on the whole, very consistent and apparently of small accidental error, it is suspected that the photoelectric cell was affected by influences akin to fatigue which made the measurements in the yellow, the red and the ultra-violet not exactly comparable with those in the green and the blue where the instrument is most sensitive. Perhaps more prejudicial may have been the disproportionately extreme sensitiveness of the cell to the trifling amounts of stray light scattered by the filters from the blue regions of the spectrum. It is hoped to repeat the observations at some future time with a receiver of the black type, preferably a thermoelectric couple. The Christiansen filters seem very convenient for stellar spectrum energy observations.

The excitation of spectral lines in expanding nebular shells: OTTO STRUVE (introduced by Edwin B. Frost). This paper deals with the star P Cygni, a "nova" which first appeared in 1600 as a third-magnitude object and which is now of magnitude 5. Its spectrum consists of bright and dark lines, similar to those of other "novae." Measurements of 110 absorption lines and of 49 emission

lines lead to the following tentative picture of this star. The nucleus is a star of effective temperature $20,000^{\circ}\text{K}$, situated at a distance of approximately 3000 light years from the sun. Due to its great distance the interstellar calcium line is exceptionally strong. The absolute magnitude is -5 , in fair agreement with the average absolute magnitude -6 found for P Cygni stars in the Magellanic Clouds. Selective interstellar absorption reduces the color temperature to about $6,000^{\circ}$. There is no line spectrum belonging to a stationary reversing layer: presumably the absorption lines are hidden by the bright lines. These, together with the violet absorption lines, originate in an expanding nebular shell. The velocity of this shell is accelerated outward, being approximately 200 km/sec in the region of formation of the hydrogen lines, and approximately 50 km/sec in the inner region where Si IV and N III are formed. The stronger absorption lines originate at lesser depths than the weaker lines. The lines of higher ionization potential originate at greater depths than those of lower potential. The radius of the shell is not known, but it is certainly very much less than that of a planetary nebula or of a nova. Departure in the mechanism of line-absorption and emission from that of ordinary thermal excitation is attributed to the low density of the shell, which precludes an active part of collisions. The remaining processes of photoelectric ionization with subsequent recombination, and of monochromatic absorption of radiation with subsequent fluorescence, under the influence of a diluted field of radiation, must lead to the observed departures from the Boltzmann law. There is some indication that the state of ionization in the shell decreases outward, and that consequently the density of the nebula decreases outward slower than $1/R^2$. The latter law would hold in an isothermal nebula.

The Ursa Major Group: J. J. NASSAU and LOUIS G. HENYEU (introduced by Ambrose Swasey). An expedient method is developed for finding stars which have a given common motion. It is essentially based on the stereographic projection of the circles of equal radial velocity and equal cross-motion in declination. The method is applied in an examination of all the 2,900 stars in the Yale Bright Star Catalogue having complete data (radial velocity, proper motion and parallax) for possible membership in the Ursa Major group. In 1921, N. Rasmuson, summarizing the work of all previous investigators, assigned 28 stars to the Ursa Major group. His study included the five Dipper stars, Sirius, α Coronae Borealis and β Aurigae. Ch. Bertaud in 1932 enlarged the group. Of the 79 stars given in his list all are of type A with the exception of 3, which are F. Our examination yielded 126 stars, each of which differed from the assumed velocity of the group by a vector whose magnitude was less than 9.5 km/sec. The mean velocity of the group in galactic coordinates, with solar motion excluded, was found to be $l=1^{\circ}.4$, $b=-6^{\circ}.0$, $V=29.5$ km/sec. The stars are moving approximately in the plane of the galaxy and in a direction about 36° from the galactic center. The space distribution of the stars is more or less spherical, with an approximate diameter for

the group of 150 parsecs. A study of the spectral and parallactic distribution shows that the selection is not at random. As compared with the spectral frequency of stars having complete data, the Ursa Major stars exhibit a gradual increase in number from M to A with half of them A types, and a complete absence of B-type stars. The Russell diagram shows all the characteristics of a type 2a open cluster in Trumpler's classification. The stars in space are divided into two groups by a gap 18 parsecs wide passing through the sun. There is no marked difference in spectral distribution or in absolute magnitude between the two groups. Their difference of velocity is 1.7 km/sec. and it is parallel to the gap. One of the boundaries of the gap is a plane marked by 33 stars. Professor H. H. Turner in 1911, utilizing all the then known stars in the Ursa Major cluster, obtained practically the same plane. This paper appears in the *Astrophysical Journal*, Vol. 80, p. 282, 1934.

Fundamental geodetic surveys in the United States nearing completion: WILLIAM BOWIE. Geodetic surveys in the form of triangulation and leveling, started during the last century as a framework for topographic maps and for use in many other engineering operations, and which have assumed marked scientific importance, are being rapidly extended over the area of this country. Marked progress has been made in these surveys during the past few years as a result of the allotment of funds to relieve unemployment. While a number of agencies, federal and others, have engaged on geodetic surveys in this country, the greater part of the work has been done by the U. S. Coast and Geodetic Survey. The plans followed on the fundamental geodetic surveys call for lines of leveling and arcs of triangulation spaced at intervals of about 25 miles over the entire area of the United States. There are now 172,000 miles of lines of levels with only 28,000 miles remaining to be done. There are 55,000 miles of arcs of triangulation and there remain 61,400 miles to complete the net. It is expected that the leveling net will be finished during the coming winter, while at the present rate of progress, the triangulation net will be finished within three or four years. During the past few years the number of surveying parties in the field and the mathematicians and computers in the office have been greatly increased, but in spite of this increase the high accuracy of the geodetic surveys has been maintained. They are at least equal to the standards adopted by the International Geodetic Association. In 1927 the triangulation net as it existed at that time was readjusted by a new method, which proved very effective. In 1929 the adjustment of the combined leveling nets of the United States and Canada was made, which furnishes the fundamental elevations for tens of hundreds of bench marks. Canada and Mexico have joined their triangulation systems to that of this country, and in consequence we have a unified triangulation net for North America. This is the only continent in which this condition obtains. Already the triangulation, with connected astronomical observations in the United States, has been used in determining the figure of the earth and that figure has been adopted as an interna-

tional one by the International Geodetic Association. With the vast increase in the amount of triangulation in North America, it will be possible to derive a new figure of the earth which should be superior to any previous ones. The first comprehensive test of isostasy was made by the use of triangulation. The adjustment of the leveling net indicates that mean sea-level as determined by tidal observations on the coasts deviates from a level or equipotential surface. Mean sea-level at Portland, Maine, is 0.39 meter higher than at St. Augustine, Florida. Ft. Stevens at the mouth of the Columbia River in Oregon is 0.86 meter higher than at St. Augustine. These values are subject to some uncertainty due to accidental errors, but they are of the right order of magnitude. Geodetic surveys have been and will be used in the future in determining the extent of the deformation of the surface of the earth in the vicinity of earthquake epicenters. The triangulation and connected astronomical observations combined with the data secured from gravity surveys will furnish information for making further tests of isostasy and in enabling geologists and geophysicists to interpret more accurately buried geological structures.

Solar prominences recorded by the motion picture method: ROBERT R. McMATH and ROBERT M. PETRIE (introduced by Heber D. Curtis). This film shows some of the results that are being secured with the spectroheliokinematograph at the McMath-Hulbert Observatory of the University of Michigan. This is the first time that the growth, motion and change of solar prominences have been depicted in a continuous record by the motion picture method. Of especial interest is the record of a solar bomb, or very short-lived prominence, whose total life was of the order of ten minutes. In this, a cloud of dark hydrogen gas was suddenly ejected from a previously quiescent sun-spot. The cloud was about $40,000 \times 19,000$ miles in size; the component of its velocity of ejection across the line of sight was 42 miles per second. However, as the sun-spot was only about ten degrees from the line of sight, the actual velocity of ejection outward must have been of the order of 240 miles per second. After the disappearance of this bomb a long faint stream of gas, either from the outburst or of other material, was sucked back into the spot with a rapidly accelerating velocity. The method has great potentialities in the study of the rapidly changing phenomena of the solar surface, and should produce results of high scientific value and educational interest.

Variation and evolution among the stars: HARLOW SHAPLEY. Published in this issue of SCIENCE.

The presence of creatinine in blood plasma: JOSEPH M. HAYMAN (introduced by A. N. Richards). Indirect evidence indicates the presence of creatinine in normal and pathological human blood serum. This is based on acceptances of Gaebler's conclusion that all the material absorbed from a blood filtrate by Lloyd's reagent and eluted can be identified as creatinine. Trichloroacetic acid filtrates were found more satisfactory than picric acid filtrates, since shaking picric acid with either kaolin

or Lloyd's reagent leads to the development of a deeper color on addition of alkali or creatinine and alkali. The rate of color development in solutions of the material eluted from Lloyd's reagent is the same as that in creatinine solutions, while the rate in serum filtrates before and after shaking with Lloyd's reagent differs from pure creatinine solutions. Trichloroacetic acid filtrates of both normal and pathologic sera show a decided reduction in the intensity of the Jaffe reaction after shaking with Lloyd's reagent. The sum of the remaining color and that obtained from material eluted from Lloyd's reagent agree with that in the original filtrate within the limits of the method. The relation between the two factions is the same, whether the increase in apparent creatinine is due to disease or ingestion of creatinine.

Further observations on systolic and diastolic coronary flow under natural conditions: CARL J. WIGGERS (introduced by Joseph Erlanger). The question whether coronary flow is retarded or even stopped during ventricular contraction, or, on the other hand, undergoes a decided acceleration during systole is still in dispute. Records obtained by flow recorders of different design give quite different answers. This is occasioned by the fact that the theoretical physical principles according to which such instruments can be designed and by which their efficiency can be evaluated have not been as clearly or comprehensively formulated as in the case of pressure recorders. Consequently, their construction is guided too largely by empirical trials, while judgment as to their efficiency becomes essentially a matter of opinion. Since consecutive changes in flow are the resultant of differences in pressure which exist from moment to moment in the peripheral and central ends of a coronary ramus, and since the pressure variations in the central end correspond to those in the aorta (Wiggers and Cotton, 1933), the variations of flow through intramural vessels should be determinable by simultaneous calibrated records of aortic and peripheral coronary pressures. Such recordings by use of optical manometers of adequate frequency were made in conjunction with my associates, Drs. Donald Gregg and Harold Green. It was soon realized that the physical limitations for our plan of deductions are that the pressure pulses recorded from the peripheral end of a coronary ramus represent effects produced by contractile stress and not transference of pressure through collateral channels. Although this appeared to be precluded by the discovery that the predominant and brusque increase in peripheral coronary pressure occurs before the rise of pressure in the aorta, additional confirmatory evidence was obtained by temporarily occluding the other coronary branches. The limiting physiological conditions for such tests were set by the immediate changes in the character and force of ventricular contractions and further by the short time that the heart survives with multiple branches occluded. Time is inadequate to detail the clever expedients through which Drs. Gregg and Green were able to circumvent these difficulties; the graphic lantern slide records attest to its accomplishment. By utilizing the calibrated pressure pulses presented, enlarging them and retracing them by means

of optical projection, the algebraic difference of pressures could easily be plotted. As shown by curves presented, it appears that under natural pressure variations in the aorta, the coronary flow is neither stopped nor retarded, as claimed by Anrep and associates; on the contrary, it undergoes first a systolic acceleration and then another acceleration early in diastole, as first postulated by Rebatel (1872). By drawing an arbitrary base line and determining the surface area beneath such curves, the relative volume flows during systole and equal intervals of diastole can be estimated. We found that the flow is smallest during systole and greatest during an equal interval of early diastole.

Criteria of acute alcohol intoxication: A. J. CARLSON. We studied the acute effects of alcohol in 3.2 per cent. beer on 150 persons, men and women, ranging from 20 to 60 years in age, and including teetotalers, moderate and heavy consumers of alcoholic drinks, primarily for the purpose of determining whether alcohol in this dilution is or is not intoxicating to an average normal adult. The beer was consumed in varying quantities and rates. The minimum alcohol intake was 27.3 cc, the maximum 208.4 cc. The rate varied from one to eight bottles of beer per hour, and the drinking time from 15 minutes to 16 hours. As control on the possible effects on liquid volume near beer was consumed in corresponding quantities and rates. It is well established that the acute effects of alcohol on the animal organism depend on the quantity, concentration and rate of consumption of the alcohol. In addition to observations of the general behavior of the subjects, determinations were made on the alcohol concentration in the blood, and in the urine, standing steadiness, hand steadiness, visual and auditory reaction time, cutaneous sensibility to pain and such mental factors as are involved in the speed and accuracy of card sorting and color naming. (1) There was no change induced in skin sensitivity to pain. (2) Consumption of from 8 to 14 bottles of beer (117 to 191 cc alcohol) in three hours induced some impairment in steadiness, reaction time, card sorting and color naming. The average maximum blood alcohol reached 1.17 mgr per cc. No consistent impairment occurred below this alcohol intake. (3) There is a fair parallel between the rate and concentration of the alcohol consumption, the concentration of alcohol in the blood and urine, the degree of impairment of performance, and the deviations from ordinary behavior, although the latter varies greatly with the individual and the kind of environment at the time of observation. (4) There is no single test or criterion for the degree of alcohol intoxication that has the social and legal implication of drunkenness. The blood alcohol concentration is significant, because none of our subjects showed "drunkenness" until the blood alcohol exceeded 1 mgr per cc. (5) The present confusion in the scientific, social and legal aspects of acute alcohol intoxication might be clarified by limiting the term "alcohol intoxication" to any and all immediate effects of alcohol, and define "drunkenness" as that degree of alcohol intoxication at which the individual becomes a nuisance or a danger to his fellow men. In our subjects the degree

of alcohol intoxication that we might call drunkenness appeared, varying with the individual, at a blood alcohol concentration between 1 and 2 mgr per cc.

The temperature of the expired air, a hitherto unused physiological and clinical measure: FRANCIS G. BENEDICT and CORNELIA GOLAY BENEDICT. The mouth and rectum as body cavities for temperature measurements have long been used. By measuring the temperature of the expired air lung temperature may be obtained. A respiratory cycle lasting but four seconds calls for a thermal junction measurement of the temperature. An extremely fine wire, copper-constantan thermal junction with thermostat and galvanometer gives an instantaneous measurement of the complete respiratory cycle. The temperature of the expired air varies with the phase of the cycle and is highest toward the end of an exhalation. With a forced inspiration and exhalation a somewhat higher temperature is obtained. This is essentially that of mouth temperature with the clinical thermometer, but is several tenths of a degree below that of the rectal temperature. For physiological purposes, school surveys, examination of recruits, etc., the body temperatures can be measured with one expiratory blast, lasting three or four seconds, as rapidly as the subjects can be handled. In the clinic the significance of true deep lung temperatures may be of great value in respiratory affections.

Energetics of growth and metabolism in the chick embryo and a calculation of the developmental efficiency of these processes: NORMAN C. WETZEL (introduced by A. J. Carlson). The general equations previously found by the author to hold between growth and heat production in the human being and in other forms have now been applied to the entire life cycle of the chicken, that is, from the first day following fertilization throughout incubation of the egg, to full-fledged maturity. The equations of growth, for example, show satisfactory agreement with the data of Byerly, Murray and Needham over the range in weight from 0.7 mg at the first day of incubation to 2 kg at maturity. Equally good agreement has been obtained for the period of embryogenesis between the calculated values on coincidental heat production and the quantity of heat actually measured by Bohr and Hasselbalch, as well as that estimated from oxygen consumption by Murray. It is of interest that the negative values for heat output (absorption) which Bohr and Hasselbalch had originally described during the first 2 or 3 days of incubation are perfectly consistent with the present calculations which also show heat absorption in contrast to heat output during the first 3 days of incubation. A balance sheet can now be drawn up to show the relations between the quantity of energy originally present in the egg and the energy comprising the various products which have been generated, namely, the chick, the heat output due to growth and the heat output due to maintenance. These results stand opposed to the idea that there is no work involved in growth. It is, in fact, possible to compute the actual quantity of work done, as well as the quantity of energy lost by dissipation, and thus to estimate the efficiency of the growth process as such. This is surprisingly high,

reaching a value of 99.67 per cent. for the entire period of incubation; for, of an original 59,208 gram-calories used in the process, only 198 are dissipated. The entire remainder is disbursed between the chick itself (37,500 gram-calories), synthesis (882 gram-calories), maintenance of embryonic tissues (18,748 gram-calories) and in the formation of the extra-embryonic membranes (1,880 gram-calories).

Rate of growth and length of life: H. C. SHERMAN and H. L. CAMPBELL. The subjects of the experiments were rats bred in our own laboratory for over 30 generations, of which several generations were included in the present study. Females grow more slowly and live longer than males. Systems of feeding which influence the rate of growth may influence the length of life in either direction: the effects of different concentrations of different chemical factors of the diet upon rate of growth and length of life are still being studied. For animals on some diets, however, sufficient data are now in hand to permit statistical study of individual variations. Here it is found that among individuals of the same heredity and sex, living in the same environment and eating *ad libitum* of the same food, rate of growth and length of life vary independently of each other.

The relative growth function applied to white-eyed mosaics of the bar series of *Drosophila*: A. H. HERSH (introduced by E. G. Conklin). The detailed knowledge available on the genetics of *Drosophila melanogaster* allows for a degree of experimental control which makes it possible to obtain information on the chain of reactions leading from the genes of the fertilized egg to their effects on the characters of the adult. One method available is to have the egg begin its development in the presence of a known genetic constitution and then during the course of development to have the genetic constitution changed in a definitely known manner. In this way a different expression of the genes may occur in that part of the body of the adult where the controlled genes produce their main effects. Such experiments were undertaken involving the following sex-linked genes: Bar, a dominant reducer of eye size; w, a recessive gene for white eye color; Minute-n, a dominant reducer of bristle size which occasionally brings about the elimination of the chromosome that carries it. Fertilized eggs were made up containing the B- and the Mn-gene in one of the X-chromosomes and the recessive w-gene in the other of the X-chromosomes. The overwhelming number of females which develop from such eggs have a red eye somewhat larger than homozygous bar but smaller than the wild-type eye. For a small percentage of such eggs, however, the BMn-chromosome is eliminated from some cell in the optic disk during the course of larval development. Such a cell and its subsequent descendants possess the single X-chromosome, containing the w-gene, and so have the genetic constitution for the production of white facets. A fertilized egg with the same genetic constitution present from the beginning of its development would produce a white-eyed male with the characteristic large eye of the wild type (about 750 facets). An elimi-

nation of the BMn-chromosome from a cell at a suitable time and place in the optic disk of the larva results in a female fly with a mosaic eye, having some red and some white facets. The earlier the elimination occurs, the larger is the patch of white facets in the mosaic eye. The data obtained were seriated on the basis of the total number of facets in the eye. For the mosaics involving the B-gene, it is found that when the entire eye (x) contains 141, 164, 189, 206, 267, 288 and 306 facets, then the number of white facets (y) is, respectively, 6.3, 9, 30.5, 24, 60, 84 and 113. These data and similar data for mosaics involving ultra-bar show that the quantitative relation closely conforms to the relative growth function, $y = bx^k$, in which x and y have the meaning indicated above, and b and k are constants. For both sets of data the value of k is about 5, indicating that the white facets increase in number about 5 times faster than total facet number. b, however, is quite different for the two sets of data; it is lower for the mosaics involving a bar gene than for those involving an ultrabar gene. Some indication of the difference can be obtained from the graph, which leads us to expect an eye with about 105 facets, if one of them only is white. A similar figure for the ultrabar mosaics is about 65 facets. Furthermore, in the case of bar, if the same relation may be extended to somewhat larger eyes than were actually obtained, then an eye with about 380 white facets would be expected to be entirely white. In the case of ultrabar mosaics, the corresponding figure is about 150 facets. Finally, on the basis of these quantitative relations it seems justifiable to conclude that in such eyes with about 380 facets, all of which are white, the elimination of the BMn-chromosome occurs not later than the very first cell whose subsequent descendants enter into the formation of the eye. But if the same genetic constitution, i.e., a single X-chromosome carrying the w-gene, is present from the beginning of development, the eye likewise will be all white, but it will contain about 750 facets. The further conclusion seems unavoidable that the B-gene in its rôle as a reducer of facet number exerts in some way an effect before the appearance of this first cell in the optic disk.

Arteriolar changes in essential hypertension: ALAN R. MORITZ (introduced by H. Gideon Wells). The contradictory character of published opinions as to the significance and even the presence of generalized thickening of the walls of small arteries and arterioles, in association with arterial hypertension in man, invites further study of the problem. Researches into the ultimate cause or causes of hypertension could be directed and executed with greater precision if it were known whether the thickening of arteriolar walls is the cause or the result of elevated blood pressure. Preliminary to any comparative study of the vessels of persons with and without a record of hypertension, it was necessary to determine if variations in the technical procedures involved in fixing, dehydrating and embedding tissues preliminary to microscopic examination might account for variations in the relative thickness of vessel walls. Such observations were made and no significant alterations in the ratios of

internal to external diameters of vessels could be related to variations in laboratory methods. Next it seemed advisable to learn if the physiological contraction or dilatation of vessels at the time of death might be rendered permanent by fixation of the tissue so that the observed differences in wall to lumen ratios could be the result of physiologic rather than anatomic change. By the repeated sampling of skeletal muscle of dogs before and after the administration of vaso-constricting and vaso-dilating drugs, it was found that neither vaso-dilatation nor vaso-constriction persisted through the process of preparing the tissue for microscopic examination. Having learned, then, that no significant alteration in the ratio of internal to external diameter of arteriolar walls could be related to artefact or to the physiological state of the vessel, it was concluded that observed differences must be regarded as significant. To determine if the walls of arterioles in persons having persistent arterial hypertension are thicker than those in persons known not to have had hypertension, two groups of cases were selected for study. The mean ratio of internal to external diameter of 75 arterioles in the skeletal muscle and 75 arterioles in the gastro-intestinal tract from each of 36 individuals known to have had persistent arterial hypertension was compared with similar ratios in a group of 36 individuals who did not have elevation in blood pressure. The populations of both groups were similar in regard to age distribution and sex. The first group was comprised of individuals on whom repeated observations of the blood pressure showed the systolic to be over 150 and the diastolic over 100, and who at death were found to have cardiac hypertrophy in excess of 400 grams and chronic renal disease. The normal group included persons who had no known elevation of blood pressure and no cardiac hypertrophy or chronic renal disease. Viewed as a group, the walls of arterioles appeared to be definitely thicker in persons having persistent hypertension than in those of the control group. Although the thickening of the arterioles was a group characteristic it was not present in all individuals who were known to have had long-standing elevation of blood pressure. This would indicate that thickening of arterioles was not a necessary or constant antecedent of hypertension, but rather that it develops in a large proportion of persons who have persistently elevated blood pressure. A study of the structural changes in these thickened arterioles revealed that the lesser degrees of thickening were the result of hyperplasia of the smooth muscle cells of the media, and that the more advanced thickening was characterized by degeneration and thickening of media and intima. These observations also support the view that the arteriolar changes were secondary to the hypertension. The measurements upon which the foregoing deductions were made have not been subjected to statistical analysis. This will be done at a later date.

On the evolution of the skulls of vertebrates with special reference to heritable changes in proportional diameters (anisomerism): WILLIAM K. GREGORY. In earlier papers the author has directed attention to the

fact that during the course of evolution of any series of organisms two opposite but often simultaneous morphological processes may be observed. In the first (named polyisomerism) there is a budding or multiplication of some given part or parts, such as the teeth of sharks or the joints of the backbone in eels. In the second or opposite process (anisomerism) there is some emphasis or selective increase or decrease among the polyisomeres, resulting either in lop-sidedness or in the diminution of certain units even to the point of disappearance. Such local differences in rates of growth have doubtless produced the observed contrasts in general appearance between the skulls of "dolichocephalic" and "brachycephalic" types of man and other mammals. In the present paper it is shown that analogous changes in the proportions of the front part of the body were already at work in the oldest known forerunners of the vertebrates, namely, the ostracoderms or pre-fishes of the Silurian and Devonian periods. The publication of important recent memoirs on these forms by Kiaer, Stensiö, Bryant and others, together with the study of original material, leads to the following conclusions: (1) The most primitive known ostracoderms were probably members of the Heterostraci, not unlike *Poraspis*. These were anisomeric in the dorso-ventral plane and bilaterally polyisomeric in the horizontal plane. (2) The head shield, composed of a many-layered shell, was divided into five primary plates. During divergent evolution both the head shield as a whole and the individual plates were subject to progressive anisomerism resulting at one extreme in the "brachycephalic" shield of *Protaspis perlatus* Bryant and at the other in the very "dolichocephalic" shield of *Podalaspis*. (3) Extreme widening of a *Poraspis*-like head shield, together with fragmentation or secondary polyisomerism of the five primary plates, would give rise to the flat shield of the drepanaspids, thelodonts and coelolepids. (4) Among the cephalaspid ostracoderms a radial expansion of the so-called upper lip or posthypophysial fold caused the displacement of the naso-hypophysial tube to the upper surface of the shield, as suggested by Stensiö; an indication of this process of expansion is seen in the many primary and secondary branches of the canals of the so-called "electric nerves," as preserved in Stensiö's material. Anisomeric expansion of the shield then produced on the one hand the extremely wide shield of *Benneviaspis* and on the other hand the long narrow shield of *Hemicyclaspis*. (5) Stensiö and Kiaer agree that the anaspid ostracoderms have been derived from the cephalaspid stem. Such derivation implies a marked secondary polyisomerism of the body segments, resulting in a long sinuous body, and a negative anisomerism of the dorsal plates of the head shield, which is reduced to a small area between the eyes, concomitant with a fragmentation or secondary polyisomerism of the rest of the head shield, the general exoskeletal pattern of the flanks tending to spread over the sides of the head and throat. (6) The existing lampreys and hag fishes, as shown by Stensiö and Kiaer, retain many deep-seated morphological characters from ancestral ostracoderms.

By secondary polyisomerism of segments the body may be more than twelve times as long as the head. By negative anisomerism the head shield is reduced and represented by the muco-cartilage plates of the larval *Petromyzon* (Gaskell). The myxinoids exhibit further degeneration of the head shield with extreme hypertrophy of the rasping apparatus, the endoskeleton of which was doubtless derived from the ventral portion of some of the visceral arches. (7) *Amphioxus* may be a greatly degraded ostracoderm which has completely lost its head shield and enjoyed enormous hypertrophy and secondary polyisomerism of the branchial apparatus, together with extreme negative anisomerism of the brain. Its nakedness is to be expected in a specialized derivative of primitively armored forms.

Post-natal growth patterns of the primate brain: T. WINGATE TODD (introduced by Aleš Hrdlička). Studies of post-natal growth in mammalian crania made in the laboratory by Schweikher, Cooke, Wharton and myself show that adult cranial capacity is very rapidly reached in non-Primate skulls. Perrine, Tracy, Krogman and I have shown that this is true also of the lower Primate cranium, but the rate of increase is not quite so great as in the non-Primate cranium. In anthropoids the rapidity of cranial growth checked against body growth is much less rapid and in man adult cranial capacity is approximately reached only at about six years. The detailed studies made in living children by Broadbent, Bolton, Richardson and myself demonstrate the local and irregular character of the cranial growth pattern. This is evident during the first year of life successively in occipital, parietal and frontal areas. The observations on children's brains made by Loo indicate that the cranial growth pattern, while not recording in detail the growth pattern of the brain, is nevertheless closely linked therewith in providing accommodation for the unequally expanding cerebral cortex. Investigations of the growing macaque brain made by Turner and myself show that the individual patterns seen in this Primate are less a problem of variation than of growth which affects more particularly the parietal area. Observations on anthropoid brains by Loo, Turner and myself present a very definite pattern of growth, expressed in post-natal life, more particularly in parietal and frontal areas. Our study of the human cortical patterns in children shows that the anthropoid growth features are reproduced and extended, the parietal and frontal areas again accounting for the bulk of the cortical expansion. Brains of subnormal and superior children point to the conclusion that individual variations are produced by interruption, aberrancy or unusual progress in the human growth pattern. These studies suggest that the cortical patterns recorded by Elliot Smith, Shellshear and Kappers on so-called primitive brains and on human paleolithic endocranial casts also represent stages in the unfolding of the human cortical growth pattern.

The fate of mercury in acute bichloride poisoning: TORALD SOLLMANN and NORA E. SCHREIBER (introduced by Dayton C. Miller). (1) The elimination of mercury was studied on two patients, with fatal, and two patients

with light mercuric chloride poisoning. Only the early vomiting expelled any notable quantities of the mercury. After the patients reached the hospital, only insignificant quantities, equivalent to $1\frac{1}{2}$ to 3 per cent. of the amount taken, were removed by extensive gastric and colonic lavage, feces and urine. (2) The organ distribution of mercury was studied in three typical cases of fatal mercuric chloride poisoning. The results agree with the scanty data in the literature. They show a surprising quantitative uniformity, although the dosage has some effect. The highest concentration occurs in the kidneys. It averages ca. 3.8 per 100 gm of moist tissue. The liver has about $\frac{1}{2}$ to $\frac{2}{3}$ of the kidney concentration, the intestines $\frac{1}{9}$, the blood $\frac{1}{40}$. The mercury content of the body at large could be estimated as about 240 mg.

Preliminary tests with sodium rhodanate on rabbits and chickens: WILDER D. BANCROFT, ESTHER C. FARNHAM and JOHN E. RUTZLER, JR. In order to determine the effect of continuous dosing, rabbits and chickens were given dilute solutions of sodium rhodanate instead of water. In one run five out of seven water rabbits died of coccidiosis as against two out of seven rhodanate rabbits. In another run two out of three water rabbits died and none of the three rhodanate rabbits. The absolute figures mean nothing and the rhodanate does not prevent coccidiosis. It seems to give increased resistance to disease. The second generation of rhodanate rabbits appears healthy. Two hundred and fifty-six twelve-weeks old chickens in poor health, all from one badly affected farm, were divided into four groups. In two months time 21 of 64 water chickens had died from infectious leukemia and coccidiosis, and 11, 11 and 7, respectively, of the three groups of rhodanate chickens. These chickens were a cross between Rhode Island and Plymouth Rocks. Three groups, 100 in each, of healthy, 10-day old, New Hampshire Red chicks from another farm are now being tested. So far, six out of one hundred water chickens have died from coccidiosis and infectious leukemia. Two of the 200 rhodanate chickens have died, one of them from an infected leg.

Present status of the adrenal cortex problem: J. M. ROGOFF (introduced by A. J. Carlson). The function of neither medulla or cortex of the adrenal gland can be satisfactorily explained. The medulla can be eliminated or its epinephrine secretion suppressed without apparent effect on life or health. The cortex (or interrenal gland tissue) is indispensable. Suppression of adrenal cortical function by excision of both glands in dogs or cats (free from accessory cortical bodies) is followed by death in one to two weeks. Survival can be prolonged, considerably, by administration of potent extracts of adrenal cortex. Such extracts often contain not only the indispensable hormone of the cortex (interrenalin) but other physiologically active substances. Therefore, aside from their capacity to prolong life of adrenalectomized animals, the use of cortical extracts in metabolic or other physiological studies may yield spurious results. Purified extracts are difficult to obtain and a definite chemical hormone has not yet been isolated. Commercially available adrenal cortical extract

has not proven satisfactory for physiological studies or for clinical use. Such extracts have been shown to contain significant amounts of protein, choline and histamine. In acute adrenal cortical insufficiency the following physiological consequences have been well established: (A) gastro-intestinal disturbances (aversion to fats, anorexia, bilious vomiting, diarrhoea, congestion and hemorrhages in the alimentary canal, congestion of the pancreas, ulcers in the stomach and duodenum); (B) circulatory and muscular asthenia; (C) nervous system disturbances (hallucinations, mania, muscular twitchings and spasms, convulsions, coma); (D) blood changes (increase in total NPN and urea N, especially with increase in the "undetermined fraction of the NPN," increase in Ca, diminished Cl, usually a moderate diminution in dextrose, increase in relative volume of corpuscles to plasma). Whether all these physiological changes are the direct result of loss of adrenal cortical function or are, in part at least, due to probable disturbed relations with other endocrine organs is under investigation. Evidence suggests involvement of the parathyroid and pancreas and probably other glands. More information might be obtained from studies upon animals in which sub-acute or chronic insufficiency of the adrenal cortex is induced. In a preliminary series of experiments upon such animals (prepared by sub-total ligations of adrenal blood vessels) the same general physiological changes were observed, but varying in degree with the degree and duration of cortical insufficiency obtained. The results in these animals afford more reliable information, on the physiology of the adrenal cortex, than comparable results obtained in human patients with chronic adrenal insufficiency (Addison's disease), since in the latter case they are confused by the presence of underlying or associated disease (usually tuberculosis). The problem at present calls for further information on the function of the adrenal cortex and its hormone, interrenalin. Recognition of insufficiency, earlier than the acute manifestations, is essential. Disturbed functional relations with other endocrine organs may yield significant information. These are the directions of our present investigations.

Current and voltage loci of polyphase circuits: A. C. SELETZKY (introduced by John B. Whitehead). The solution of unbalanced polyphase circuits by application of the classical method entails such cumbersome forms involving complex quantities as to make it impractical for engineering purposes. Various methods have been devised to shorten the labor of such computations. These are valid for a fixed condition of the network, thereby necessitating a point-by-point solution if it is desired to express any quantity as a function of some circuit parameter. Since all power systems operate at constant frequency, any current or voltage existing in a polyphase circuit, composed of bilateral linear impedances and constant electromotive forces, can be expressed as a function of any impedance element in the form of a linear fractional transformation. The variable impedance element may vary: (a) along its resistive component with fixed quadrature component; (b) along its quadrature com-

ponent with fixed resistive component; and (c) in magnitude at constant phase angle. With any impedance element considered as a variable, the most general form of locus of current or voltage is a circle, degenerating in certain cases into a straight line. The same holds true for symmetrical components of all voltages and currents and unbalance factors thereof. Thus by resolution of the desired quantity into a linear fractional transformation, the solution is reduced to determining three points on the circular locus, two of which may be invariant points, thereby simplifying the computation. With the position of the circular locus determined, a linear scale line may be drawn which enables one to read off directly from the plot the magnitude and phase of the desired quantity for any value of the variable impedance. The paper gives detailed analytical solutions of the Y-Y and Δ - Δ systems and a numerical solution of a typical Y-Y circuit.

Variations in tilt lines in the Huron-Erie district: FRANK LEVERETT and DONALD C. MACLACHLAN. The shores of glacial lakes in the Huron-Erie district show a notable difference in the trend of tilt lines in lakes of different age and also in different parts of the shore of a given lake. In the district west of Lake Huron the tilt line of Lake Arkona bears but a few degrees east of north while that of Lake Warren, a later body of water, bears about NNE. This seems to show that the area of uplift was shifted eastward at the time of the later lake. The tilt line of the Lake Warren shore changes from NNE on the borders of the Huron Basin to about NE on the peninsula between the Huron and Erie basins, but takes a NNE trend on the borders of the Erie Basin. It is thought that relief from ice weighting, which came earlier on the high land between the basins than it did in the basins, may have allowed it to be uplifted somewhat in advance of the uplift within the basins, and thus have induced the peculiar trend. The rate of uplift of the Lake Warren shore is not uniform, nor does it show a progressive increase from south to north. On the east side of the Huron Basin its profile shows changes from a rate of several feet per mile to a much lower rate in the general direction of the tilt line. Variations of this kind in the shores of Lake Algonquin on the borders of Lake Simcoe were brought to notice by W. A. Johnston in 1916, and tentatively connected with a fault that appears to have been developed there in late Pleistocene time. Whether the variations noted in the Warren shore are to be thus explained is not yet known.

Nature and extent of Tertiary formations immediately following the Columbia lava flows of the northwest: JOHN C. MERRIAM. In description of the series of formations in the John Day valley of eastern Oregon, published in 1901, the writer described under the name of the Mascall Formation a series of deposits in a depression formed by the down-folded Columbia lavas. It was noted that the dip of the lower Mascall is approximately the same as that of the lavas upon which it rests. Reference was made to the fact that the Ellensburg beds of central Washington are probably in part of the same age

as the Mascall, and that a similar formation occurs in the Crooked River region to the south. There has been question as to the original extent of the Mascall and discussion of its possible extension over a considerable part of the Columbia lava region east of the Cascades in Oregon and Washington. The purpose of the present note is to call attention to the fact that as studies have been extended by geologists and paleontologists in eastern Oregon and Washington the number of localities representing beds of the Mascall type has gradually increased. It is now important to have a study of the whole area with mapping of the beds of the Mascall stage and careful paleontological determination of the horizons. There is reason to believe that beds of the type of the Mascall may have existed over a considerable part of the Columbia lava region in the latter part of Miocene time. The present occurrences of Mascall may be due to post-Mascall depressions through which certain areas have been subject to relatively less intensive erosion, leaving relics of this formation to be covered in part by later accumulations.

Recent developments in Diesel engines: CHARLES F. KETTERING.

Some notes on the aging of metals: HERBERT M. BOYLSTON (introduced by Albert Sauveur). After an introductory historical sketch of the discovery and development of the phenomenon known as "The Aging of Metals" the important work of Merica, Waltenberg and Scott is reviewed briefly, while the later writings of Jeffries and Archer, Sauveur and W. P. Sykes are reviewed. Some results obtained in the Metallurgical Laboratories of Case School of Applied Science by M. Charlton and E. S. Steigner are then described. Their work included the study of the effect of cobalt additions on the age-hardening properties of iron plus 20 per cent. molybdenum and the age-hardening properties of iron plus 15 per cent. molybdenum. It is shown that these workers were able to increase the Brinell hardness of certain of these alloys by age-hardening from a hardness after quenching of approximately 15 to 43 Rockwell C. (179-352 Brinell) depending on the temperature from which the alloy was quenched and the amount of cobalt in the alloy to a hardness from 46 Rockwell C. (388 Brinell), where the hardness after quenching but before aging was approximately 16 Rockwell C. (183 Brinell), to a Rockwell hardness of C-68 (712 Brinell) in the case of an alloy containing 30 per cent. cobalt, 15 per cent. molybdenum, the balance iron where the hardness after quenching was about 49 Rockwell C (429 Brinell). Steigner, working with an alloy containing 20 per cent. molybdenum and 25 per cent. cobalt, balance iron, was able to increase the hardness from Rockwell C-46.5 (394 Brinell) in the quenched condition to 68.6 Rockwell C. (723 Brinell) when age-hardened. It is also shown that with copper containing approximately 2½ per cent. beryllium the hardness was increased from the as-rolled condition of C-20 (197 Brinell) and the hardness after quenching of C-12 (167 Brinell) to C-40 to 42 (331-346) after quenching from 1,450 deg. Fahrenheit and aging for one hour at 570 deg. Fahrenheit.

The significance of the persistence of the crystalline state above the melting point: ROBERT E. BURK (introduced by E. P. Kohler). To be published later.

The thermal decomposition of ammonia on metallic surfaces: ERIC A. ARNOLD (introduced by Roger Adams). The thermal decomposition of ammonia has been investigated on the surface of ruthenium. It was found that nitrogen as a product had no effect on the speed of the reaction, but the hydrogen had a marked retarding effect. By assuming that the seat of the reaction is the absorbed film of gas on the surface of the metal and further postulating a monomolecular film, an equation has been developed which quite satisfactorily expresses the experimentally observed rates of decomposition. From the assumptions set up, the mechanism of the decomposition of ammonia on ruthenium may be inferred. Similar work is now in progress using rhenium as the metallic surface.

The present status of studies on photosynthesis: O. L. INMAN (introduced by Charles F. Kettering). In recent years investigators in this field have come to realize more and more that the process of photosynthesis is one of the borderlands where radiant energy and chemical synthesis meet. Many chemical reactions in the living organism are brought about by energy derived from the oxidation of some carbon compound, which in turn originated by the reduction of some other carbon compound. However, in the process of photosynthesis, the carbon dioxide is reduced not by energy from some simultaneous oxidation, but by the energy from the sun. Since the living cell of the green plant is the place for this reduction, one is always faced with the problem of analyzing physico-chemical processes taking place in protoplasm. This does not lighten the burden of obtaining a satisfactory understanding of the reactions involved. Workers in this field have found much difficulty in trying to strike an energy balance between the visible light absorbed and the carbohydrates manufactured. Warburg and Negelein made considerable progress in this direction when they found that in the cells of *Chlorella pyrenoides* one molecule of carbon dioxide was reduced for every four quanta of light absorbed. Noack has reported the probability of surface reactions on the chloroplasts with iron acting as a catalyst. Other workers consider magnesium in the chlorophyll molecule as directly linked with the chemical reactions between carbon dioxide and water. One must also bear in mind that diffusion through semi-permeable membranes can not be neglected in dealing with reactions within the living organism. The recent chemical studies of the chlorophyll molecule by Hans Fischer, Conant and others have begun to indicate new lines of attack on the problems of photosynthesis, but much still remains to be done in applying these chemical studies to the mechanism of photosynthesis. Many investigators have been interested in the possibility of a chlorophyll-carbon dioxide compound. Evidence is accumulating that some such chemical combination takes place. The work of Emerson and Arnold, Padoa and Vita and others, as well as our own

experiments, strongly suggest this. Some of our results also point to a definite probability that chlorophyll as a functioning molecule in the chloroplast may be bound to a certain class of proteins. Acetylene has recently been proposed as a possible intermediate compound in the formation of carbohydrates. Artificial photosynthesis or the duplication of the work of the green plant in the laboratory seems rather remote at the present time.

Chlorophyll and the protochlorophyll problem: PAUL ROTHMUND (introduced by Charles F. Kettering). With the increasing knowledge about the reactions and the structure of chlorophyll the problem of chlorophyll formation becomes important. Some investigators believe that chlorophyll is formed from a colorless precursor, protochlorophyll, chlorophyllogen or leucophyll by oxidation, in general in sunlight. Noack states that Monteverde's protochlorophyll, which occurs in small quantities in plants grown in the dark, is a reduced magnesium containing substance of porphyrin character. On the other hand, the suggestion has been made that protochlorophyll is not the precursor of chlorophyll but rather a decomposition product formed due to special environmental conditions of the plant. In our experimental studies we are considering both of these theoretical interpretations. White and yellow corn was grown in absolute darkness for about two weeks and worked up by a special technique to prevent the material from changing its protochlorophyll into chlorophyll, a change which would occur under the influence of light. Extraction with acetone and transfer into ether yielded a

yellow solution exhibiting red fluorescence and a typical absorption spectrum. By using chromatographic adsorption analysis a solution free from yellow plant pigments was obtained. Crystallized material is not available yet. Chlorophyll and pheophytin were reduced according to Noack with iron in 80 per cent. formic acid. The 18 per cent. hydrochloric fraction of the reaction mixture in ether yielded crystals of m.p. 246° containing methoxyl, but no magnesium. The hydrolyzed product was also prepared. Noack reported mixtures of substances resulting from this experiment. The reduction of chlorophyll or chlorophyll derivatives in pyridine solution with zinc dust and acetic acid was performed in nitrogen and in carbon dioxide atmosphere. The resulting colorless solutions were reoxidized by the oxygen of the air whereby the green color came back. The absorption and fluorescence spectra of the original, the reduced and the reoxidized solutions were studied. Reoxidation causes the formation of several substances; the separation of this mixture is under way. The reduction products obtained by the two methods are different from each other and are also different from protochlorophyll prepared from etiolated plants. Absorption and fluorescence spectra also reveal that the products from the reduction with zinc dust in carbon dioxide are not identical with those formed in nitrogen atmosphere. Details of these investigations will be published elsewhere.

Elements and general Jupiter perturbations of ten Watson planets: A. O. LEUSCHNER. To be published later.

SCIENTIFIC EVENTS

THE RANGE OF THE JAPANESE BEETLE

THE U. S. Department of Agriculture, in its annual survey of the spread of the Japanese beetle, found a well-established infestation at St. Louis, Mo.; a less extensive one at Indianapolis, Ind., and another at Charlottesville, Va. According to Lee A. Strong, chief of the Bureau of Entomology and Plant Quarantine, with these three exceptions, no real infestation came to light outside the beetle's established range in Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, New Jersey, Pennsylvania, Rhode Island, Vermont, West Virginia, Virginia and the District of Columbia.

Through the instrumentality of plants or other materials, Japanese beetles are likely to establish themselves at points remote from the area along the Atlantic seaboard where they are firmly entrenched. To delay long-distance advances, the Department of Agriculture, through the federal plant quarantine, seeks to keep all products that might harbor the beetle from being shipped from infested to non-infested territory.

The largest control program so far undertaken against the Japanese beetle at an isolated infestation is now under way at St. Louis. Lead arsenate pro-

vided by the Federal Government is being applied to the soil in the 117 city blocks. The local relief administration is supplying laborers to assist in applying the material and the city fire department is lending hose lines. Similar measures, though on a smaller scale, will go into effect in the limited sections found to be infested in Indianapolis and Charlottesville.

Owing to a curtailment in funds, only 31,000 of the 56,000 traps owned by the Department of Agriculture were used this year. These traps were operated from Virginia to Maine. New catches were recorded in 5 cities in Maine; in 58 Maryland communities, both inside and outside the regulated zone; in Detroit, Mich., where a few beetles have been trapped each year since 1932; in 9 New York cities; in 6 localities in Ohio; at Erie, Pa., where an infestation was discovered in 1931; in 6 cities in Virginia, and at 7 points in West Virginia. In none of these places is the beetle well established. Either the numbers found were too small to constitute real infestations or the beetles present were the survivors of incipient infestations that are not increasing.

The results of the survey are said to show no need for changing the existing quarantine or for bringing

any additional territory under quarantine. The quarantine already in force in the infested areas will be continued.

RELATIONS OF THE UNIVERSITY OF CALIFORNIA WITH PUBLIC AND PRIVATE BUSINESS

A STATEMENT of the general policy to be followed by the University of California in making its facilities available for the use of the public or of private business, and the extent to which faculty members will be permitted to engage in private employment, has been issued by President Robert G. Sproul.

Dr. Sproul said that the statement is issued "in order that there may be a clear understanding, both by members of the university and by the public, concerning service by the university or by members of its faculty to the people and the industries of the state."

In order to aid in directing this service policy, an advisory committee of faculty members and university alumni has been named to cooperate with the administration. It includes: Dean Charles Derleth, of the College of Engineering; Dean C. B. Hutchison, of the College of Agriculture; Professor B. M. Woods, chairman of the department of mechanical engineering; Dr. R. E. Davis, professor of civil engineering; Dean F. H. Probert, of the College of Mining; Alex J. Dickie, '98; Donald L. Kieffer, '19, and E. L. Oliver and Max Thornburg, '21.

The service policy outlined by Dr. Sproul provides:

Members of the university may render professional service for compensation as long as such service does not interfere with their prescribed duties and unless their university employment forbids them to accept additional employment, or their appointment requires them to render a consulting or advisory service without charge.

Within these limits, teachers of professional subjects are encouraged to engage in the practise of their professions so far as may be necessary to maintain professional competency. Such activities are to be engaged in under private arrangement, and fees charged are to be on a scale prevailing within the professions practised. The university will not approve the employment of its members, however, in routine tasks of a commonplace type, undertaken primarily to supplement personal income.

The participation of the university itself in tests and investigations shall be limited to activities leading to the extension of knowledge or increased effectiveness in teaching. No tests or investigations shall be undertaken by the university which might interfere with the teaching responsibilities of a faculty member.

The results of all tests and investigations made by the university shall be available for common use by the public and shall not be for the exclusive use of parties sponsoring or conducting the work.

The laboratories of the university shall not be made

available for tests of a purely commercial nature unless satisfactory facilities for such tests do not exist elsewhere.

Commercial tests involving controversial elements are not to be undertaken except at the direct and unanimous request of representatives of all parties to the controversy.

The university is to make a charge ample to cover all direct and indirect costs of all tests or investigations which it undertakes.

The use of the name of the university for purposes of advertising will not be tolerated.

THE YALE SCHOOL OF MEDICINE

A SLIGHT increase in the amount available for research problems in Yale University School of Medicine during the year 1933-34 is reported by Dean M. C. Winternitz in his annual report to President James Rowland Angell. During the period of the depression no decreases in the salary scale nor in research funds have occurred, although fewer appointments and promotions have been made. The appointment of assistants to aid senior men in their individual research work is recommended in the report. The plan is to give certain senior investigators two aids with no responsibilities other than the research work of the staff member to whom they are assigned. Appointments are to be for two years and they are to expire in alternate years so that one of the two men will always have had one year's experience on the project.

The number of students enrolled during the year was 211 of whom 40 graduated. All graduates obtained internships and are located in 31 hospitals in 16 cities and 9 different states. One out of every six students in the school is entirely self-supporting. Half of the students either work during the school year to help support themselves or receive scholarship aid.

Dean Winternitz expresses a belief that the medical curriculum must remain within certain definite limits, but that the field must be exposed to the advances in the social sciences as well as in the biological sciences. The Institute of Human Relations, he reports, has encouraged a number of social studies in which the rôle of health has been given careful consideration, and it is expected that from these other studies may develop which may help the physician to evaluate more satisfactorily the contributions which medicine can make to the health of the individual.

THE INTERNATIONAL COMMISSION ON ILLUMINATION

THE 1935 session of the International Commission on Illumination will be held in Berlin, from July 2 to 9, according to an announcement made by the United States National Committee. The committee, which held its annual meeting in New York on November 9, includes among its membership representatives

from the American Institute of Electrical Engineers, the Illuminating Engineering Society, the Optical Society of America, the American Physical Society and the Bureau of Standards. E. C. Crittenden and C. H. Stickney were reelected, respectively, to the offices of president and secretary-treasurer of the United States Committee, as well as being reappointed United States members of the International Executive Committee, of which body Dr. C. H. Sharp, vice-president, is also a member.

The United States Committee reviewed the reports of its representatives on the twenty-seven technical committees and made plans for participation in the Berlin meetings. The United States secretariats manage three of these technical committees, namely: Factory and School Lighting, Aircraft Lighting and Lighting Education. In Factory and School Lighting, world-wide statistical surveys are being made on conservation of eyesight, special attention being given to the welfare of school children with defective vision. Because of the international character of aerial navigation, important standards for lighted signals are being set while the practices are still flexible. An English-French-German vocabulary of special terms is being established.

The commission is cooperating with the International Committee on Weights and Measures, an organization established under international treaty to which this country is a party. Progress is well under way to the establishment of a primary standard of light and toward the elimination of certain discrepancies in light measurement, which have proved embarrassing. The accurate measurement of the new gaseous tube electric illuminants, which is becoming more and more increasingly important, will also be considered.

These and many other vital questions are scheduled for discussion in Berlin, not the least of which are street and automobile lighting, in connection with which considerable differences of opinion exist in various countries.

The National Committee is endeavoring to secure a large attendance of American experts in order to insure an adequate expression of the view-points prevailing in this country.

GRANTS FOR RESEARCH AT WESLEYAN UNIVERSITY

WESLEYAN UNIVERSITY's interest in research, which has already brought endowments of more than \$100,000 for this work, has resulted in a special grant of \$9,500 by the trustees to supplement the endowment funds. The previously established endowments for research work include the Charles Himrod Denison Foundation for biological research of \$75,000 and the Atwater fund of \$30,000 to support research in chem-

istry. The position of a research associate in astronomy is also regularly maintained.

The grant for the current year is to be used for needs not supplied from these funds. A portion is allotted to secretarial service in various departments of the college, while \$1,000 is set aside as a travel fund to defray expenses incurred by members of the faculty in attending meetings of learned societies. The balance is given to aid special projects.

In the department of astronomy a grant is given Professor Slocum for employment of student computers in connection with the observatory program of study of stellar parallaxes. Professor Camp, of the department of mathematics, is given funds for special assistance in connection with mathematical problems which have been submitted by the research committee of the American Statistical Association. These are chiefly economic problems of which a statistical analysis is desired. A grant is given Professors Cady and Van Dyke of the department of physics for a research program on piezo-electricity and related problems. These investigations are of importance in the science of radio transmission. Assistant Professor Langlie of the department of psychology is given a grant for secretarial help in connection with his personnel work with Wesleyan students and his special studies on relation of learning and temperament.

COMSTOCK HALL AT CORNELL UNIVERSITY

ACCORDING to *The Cornell Alumni News*, Comstock Hall is now the official name of the building formerly occupied by the College of Home Economics of Cornell University, which now houses the department of entomology. It is named for the late Professors John Henry Comstock, '74, and Anna Botsford Comstock, '85. The *News* writes:

Professor Comstock it was who first worked out a system by which insects, like plants, might be identified and classified, based on the venation of their wings. His books and other writings, for the proper illustration of which Mrs. Comstock learned wood engraving, are still the standard authorities in the field. Most of the leading entomologists in the country have been his students as have those in the field of nature study followed the lead of Mrs. Comstock. Besides their unquestioned leadership in their chosen fields, Professor and Mrs. Comstock became, in their fifty years of residence at Cornell, among the best-loved members of the university community. Mrs. Comstock died on August 24, 1930, and Professor Comstock six months later, on March 20, 1931. The bulk of their estate was left to the university, including their interest in the Comstock Publishing Company, which they owned with Professor Simon H. Gage, '77. Their will provided also for the establishment of the Grove Karl Gilbert Student Loan Fund.

The new quarters of the department comprise some 30,000 square feet of floor space. In 1872 the systematic study of insects at the university began in the tower room of McGraw Hall, just below the university's great bell and the nine smaller bells of the McGraw chimes. John Henry Comstock, then a junior in the Natural History Course, was also master of the chimes. In the fall term of 1872-73 C. V. Riley, of St. Louis, Missouri, gave a course of twelve lectures on economic entomology, but it was not until the next year, with Dr. Comstock an instructor in economic entomology in the School of Agriculture, that resident courses in the subject were given. In 1881 the department was moved to the second floor of White Hall, and since 1906 had been housed in Roberts Hall.

The work in entomology, limnology and apiculture now occupies the five floors of Comstock Hall, with a staff of nine professors under the headship of Dr. James G. Needham, '98, two assistant professors and twelve instructors. Ornithology, under the direction of Professor Arthur A. Allen, '07, remains in McGraw Hall. In addition to the numbers of undergraduates who take courses

in the department, fifty-six graduate students chose majors in entomology in 1933-34.

Outlying links with the department include an insectary, an experimental fish cultural station, a biological field station, and three wild life preserves, all of them aggregating 650 acres.

RECENT DEATHS

DR. THEOBALD SMITH, president of the board of scientific directors of the Rockefeller Institute for Medical Research, from 1915 to 1929 director of the department of animal pathology at Princeton, New Jersey, died on December 10 at the age of 75 years.

DR. PALMER C. RICKETTS, president since 1901 of the Rensselaer Polytechnic Institute and a member of the faculty since 1875, died on December 10 at the age of 78 years.

SIR HORACE LAMB, from 1885 until his retirement in 1920 professor of mathematics at Owens College and the University of Manchester, has died at the age of 85 years.

SCIENTIFIC NOTES AND NEWS

DR. GEORGE H. WHIPPLE, of the School of Medicine and Dentistry of the University of Rochester, and Dr. George R. Minot and Dr. William P. Murphy, of the Harvard Medical School, joint recipients of the Nobel prize in physiology and medicine, were present at ceremonies held in Stockholm, on December 10, on the occasion of the presentation to them by King Gustaf of the diplomas, gold medals and money awards. Professor Harold C. Urey, of Columbia University, who was awarded the prize in chemistry, was unable to be present, but expects to go to Stockholm in February.

At the annual dinner and meeting of the New York Academy of Sciences, to be held at the American Museum of Natural History on December 17, the speakers will be Dr. Harlow Shapley, director of the Harvard College Observatory, and Dr. Clyde Fisher, of the American Museum. The subjects of their addresses are, respectively, "An Explorer in the Metagalaxy" and "The Sun and Moon in Motion Pictures."

DR. CHARLES NORRIS, who since 1918 has been chief medical examiner of New York City, has been presented with a gold medal by the New York Academy of Medicine for "his outstanding work in forensic medicine." On this occasion Dr. James Ewing made the presentation, and Mayor La Guardia delivered an address.

DR. ERNEST BROWNING FORBES, director of the Institute of Animal Nutrition of the Pennsylvania State College, was the honor guest of the American Society

of Animal Production at its twenty-seventh annual meeting in Chicago on November 30 and December 1. At the banquet, a portrait of Dr. Forbes, painted by Robert W. Grafton, was presented to the Saddle and Sirloin Club for inclusion in its portrait gallery of those who have notably served animal industry and agriculture.

A PORTRAIT of Dr. Leo F. Rettger, professor of bacteriology at Yale University, was presented to the department by his friends and former students at a meeting on December 1 of the Connecticut River Valley Branch of the Society of American Bacteriologists. The portrait was painted by W. S. Cummings, of the Yale School of Fine Arts.

DR. GEORGE A. BOLE, for nine years director of ceramic research in the Engineering Experiment Station of the Ohio State University, was recently presented by the Ohio Ceramic Industries Association, in recognition of his contributions to the ceramic industry, with three vases, the work of Dr. Charles F. Binns, whose death has since occurred, accompanied with an illuminated manuscript. Presentation was made at the annual meeting of the association by W. Keith McAfee, past-president, who spoke briefly of the career of Dr. Bole.

A. E. MARSHALL, consulting chemical engineer of New York City, was reelected president of the American Institute of Chemical Engineers at its recent annual meeting in Pittsburgh.

PROFESSOR ARTHUR W. HIXON, of Columbia Uni-

versity, was elected on December 7 chairman for 1935 of the New York section of the American Chemical Society. Other officers elected were: Dr. L. W. Bass, director of research of The Borden Company, *vice-chairman*; Dr. D. P. Morgan, chemical economist for the firm of Scudder, Stevens and Clark, *secretary-treasurer*.

DR. DAVID LINN EDSALL, dean of the Harvard Medical School and of the School of Public Health of Harvard University, will retire with the title of dean emeritus at the end of the academic year.

DR. FREDERICK B. MANDEVILLE, formerly chief röntgenologist at the Paralta Hospital, Oakland, California, has been appointed full-time professor of röntgenology and röntgenologist to the hospital division in the Medical College of Virginia, Richmond.

DR. ROSWELL H. JOHNSON, formerly of the University of Pittsburgh, has been appointed social hygienist in the Palama Settlement, Honolulu, and part-time professor in the University of Hawaii. He will give courses in social hygiene and eugenics.

HURLBUT S. JACOBY, now holding an administrative position in engineering with the National Recovery Administration, has been appointed to the new position of director of industrial research which has been established at the Ohio State University. Mr. Jacoby is the son of Henry S. Jacoby, emeritus professor of engineering of Cornell University.

W. C. MILLER, lecturer in the department of animal genetics at the University of Edinburgh, has been appointed professor of animal husbandry at the London Veterinary College.

PRINCIPAL DR. T. S. WHEELER, of the Royal Institute of Science, has been elected dean of the faculty of science and a member of the syndicate of the University of Bombay.

THOMAS ROWATT has been appointed director of the Royal Scottish Museum, Edinburgh, in succession to the late E. Ward.

Nature states that Dr. James Davidson, lecturer in the department of pathology in the University of Edinburgh, has been appointed officer in charge of the scientific laboratory which is to be instituted at the London Police College at Hendon. Dr. Davidson's main function will be to assist in the investigation of criminal cases, to give instruction in scientific methods of crime detection to students at the College and at Peel House and to other members of the force, and to undertake research work.

A GRANT has been made to the University of Chicago by Nathan Dauby, Cleveland, and Morton J. May, St. Louis, trustees of the Beaumont Foundation

of Cleveland, for the purpose of supporting the researches on the adrenals and other ductless glands of Dr. J. M. Rogoff, formerly associate professor of experimental medicine at Western Reserve University. Dr. Rogoff is now working in the department of physiology at the University of Chicago.

THE Committee on Scientific Research of the American Medical Association has made a grant to Dr. Paul L. Day and Dr. William C. Langston, of the University of Arkansas School of Medicine, for studies on the effect of vitamin G withdrawal on the monkey.

THE Ramsay Memorial Fellowship Trustees have made the following awards of new fellowships: G. C. Hampson, a British fellowship of £300, tenable for two years, at the University of Oxford; George Bryce, a Glasgow fellowship of £300, tenable for two years at the University of Cambridge; M. Berton, a French fellowship, at the Imperial College of Science and Technology, London; Dr. Charles Haenny, a Swiss fellowship of £300, at Birkbeck College, London; Professor G. Semerano, an Italian fellowship of £300, at the Imperial College of Science and Technology, London; Dr. M. G. van ter Horst, a Netherland fellowship of £300, at the University of Cambridge. The trustees have renewed the following fellowships for the same year: Dr. C. Kawassiadis (Greek Fellow), Ramsay Memorial Laboratory of Chemical Engineering, University College, London; Dr. Ikutaro Sawai (Japanese Fellow), University College, London; Dr. A. G. Winn (British Fellow), University College, London.

DR. SIMON FLEXNER, director of laboratories, Rockefeller Institute for Medical Research, New York, will deliver the Pasteur Lecture of the Institute of Medicine of Chicago, on April 26. His subject will be "Virus Diseases of the Central Nervous System: their Extent and Mode of Infection."

DR. FRANCIS G. BENEDICT, director of the Nutrition Laboratory of the Carnegie Institution of Washington, was the guest speaker at the Western Reserve University Chapter of the Society of the Sigma Xi on November 21. Dr. Benedict spoke to an audience of one hundred and fifty chapter members and their guests on "Body Temperature" with special reference to human and animal physiology. Dr. V. C. Myers, past-president of the chapter, presided.

COLONEL FIELDING H. GARRISON, librarian of the William H. Welch Memorial Library of the Johns Hopkins University, addressed the faculty and students of the School of Medicine of Vanderbilt University on October 18, on "Life as an Occupational Disease."

C. C. PATERSON, director of the research labora-

tories of the General Electric Company, Wembley, England, gave a lecture at the Royal Institution on November 21 on "The Liberation of the Electron." It was the first of a new series of four research and development lectures arranged by the British Science Guild and the Royal Institution. Lord Eustace Percy, M.P., presided.

THE list of DeLamar lecturers at the Johns Hopkins University for the present academic year, with dates and topics, are as follows: November 20, Dr. James Angus Doull, professor of hygiene and public health, Western Reserve University, "The Epidemiology of Leprosy with Particular Reference to a Recent Study in the Philippines"; December 4, Dr. Alfred J. Lotka, general supervisor, Statistical Bureau, Metropolitan Life Insurance Company, "The Adventure of Life"; January 15, Dr. Leslie T. Webster, associate member, Rockefeller Institute for Medical Research, "Host Response to Infectious Agents"; February 19, Dr. Harrison P. Eddy, civil engineer, Boston, "Municipal Sanitation and the Public Health"; March 19, Dr. F. Maurice McPhedran, assistant professor, The Henry Phipps Institute, University of Pennsylvania, "The Pathogenesis of Tuberculosis in Relation to its Public Health Economics"; early in April, Dr. Richard E. Seammon, dean of medical sciences, the University of Minnesota, "The Effect of Plague on Western Europe."

THE Committee on Scientific Research of the American Medical Association invites applications for grants in aid of research on problems bearing on the clinical aspects of medicine and surgery. Inquiries may be addressed to the committee at 535 North Dearborn Street, Chicago, Illinois.

THE School of Mathematics of the Institute for Advanced Study, Princeton, N. J., each year allocates a small number of grants-in-aid to young mathematicians and mathematical physicists "for the purpose of enabling them to broaden their scientific outlook and to work on their research programs at Princeton in contact with the members of the institute and university faculties." Only such candidates will be considered as have already given evidence of ability in independent research comparable at least with that expected for the degree of doctor of philosophy. Applications for the academic year 1935-36 should be filed before February 1, 1935. Blanks for this purpose may be obtained from the School of Mathematics, The Institute for Advanced Study, Fine Hall, Princeton, N. J.

At the annual meeting of the Board of Trustees of the Laboratory of Anthropology at Santa Fé, it was voted to amend the constitution to provide for an advisory board of not to exceed thirty-two members.

The advisory board elects from among its members the chairman and vice-chairman of the laboratory to serve for one year. These officers, together with six other members of the advisory board serving for three years each, will constitute the active Board of Trustees. The Board of Trustees will meet twice a year, once in Santa Fé and once in the East, the eastern meeting being timed to correspond with the annual meeting of the advisory board. Members of the board are: A. V. Kidder, *chairman*; C. E. Guthe, *vice-chairman*; Elsie Clews Parsons, A. L. Kroeber, J. F. Zimmerman, Fay-Cooper Cole, H. S. Colton and Duncan Strong.

THE Division of Applied Mechanics, of the American Society of Mechanical Engineers, beginning in March, 1935, will publish a *Journal of Applied Mechanics*, with the cooperation of: Dr. R. Eksbergian, Dr. J. Goff, Professor J. C. Hunsaker, Dr. J. P. Den Hartog, Professor T. von Kármán, Professor G. B. Karelitz, Dr. A. Nadai, Mr. A. I. Lipetz, Mr. J. Ormondroyd, Mr. R. E. Peterson, Professor S. Timoshenko. The technical editor will be J. M. Lessells, Swarthmore, Pa. The *Journal* will appear four times each year in issues containing about eighty pages each. It will consist of original papers in general mechanics, elasticity, hydrodynamics, aerodynamics, strength of materials and thermodynamics, similar to those published during the last few years in the *Transactions* of the Division of Applied Mechanics. Emphasis will be made as heretofore on the industrial applications of such research. It will also contain book reviews and reports of research work in engineering mechanics.

DEFINITE proof that the smaller European elm bark beetle is a carrier of Dutch elm disease has been obtained by entomologists of the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture, according to an announcement made at a conference on this disease on December 5 by William Middleton. Mr. Middleton and his coworkers have proved that beetles from infected elms are contaminated with the fungus of the disease and transmit it when feeding in the crotches of healthy trees. Three instances of such transmission have been obtained on three different elm trees. The possibility that many other insects, including other boring species and sucking and leaf-eating insects, are carriers of the fungus of Dutch elm disease remains to be studied. So far, however, the bark beetle, *Scolytus multistriatus*, is the only insect known in this country to carry the infection from one tree and implant it in another. Observations to date indicate that there are two complete and a partial third generation of the beetles annually and that from about the middle of May until after the

middle of September, there is an almost continuous supply of adult beetles. The retarded individuals of one generation overlap the more advanced individuals of the subsequent generation.

AFTER searching the deserts and foothills of Russian Turkestan and most of Turkey for plants to control soil erosion, H. L. Westover and C. R. Enlow, plant explorers of the U. S. Department of Agriculture, have returned with about 1,800 lots of seeds after an expedition lasting seven months. Because of the unusually adverse conditions for plant life where much of this seed was collected, it is hoped that plants of real value for the Great Plains and the Southwest will be found in the collection. Most of the collections represent grasses or legumes which form a thick turf close to the ground. Others represent shrubs whose root systems looked promising as soil-binders. Seeds from a few trees also were brought back. Most of the seed lots came from plants that are edible by live stock, but this quality was not regarded as of principal importance in making selections. Officials of the Soviet governments gave the explorers every possible assistance. Botanical experts were able in almost every instance to give all the necessary information concerning the plants of the regions visited. This information made it possible to avoid plants that are poisonous or otherwise undesirable. The officials of the various republics supplied automobiles, horses and camels to transport the exploration party over

Turkestan. Turkish government officials likewise cooperated in every way.

The department of physics of the University of Maine was host on October 27 to the staff members of the departments of physics of all the other colleges in Maine. This group meets twice each year for the purpose of discussing the teaching of physics in the Maine colleges. After an informal inspection of the laboratories, the program was opened with a paper on "Modern Concepts of Physical Units" by Professor N. C. Little, head of the department at Bowdoin College and a member of the committee on units of the American Association of Physics Teachers. The second paper was by Professor William R. Whitehorne, head of the department at Bates College, on a phase of photographic copying now being carried on there. Following a luncheon served in the physics library, the afternoon session was opened with a discussion of a new type of thermal conductivity apparatus by Professor A. L. Fitch, of the University of Maine. Following this came a discussion of grades in beginning physics led by Professor C. B. Crofutt. Two papers were given concerning researches at the university. R. A. Allen, a graduate student of physics, described an experimental study of the magnetic field intensity in the neighborhood of a long solenoid, and Professor C. E. Bennett described his researches on the optical constants of gases.

DISCUSSION

BALANCED DIETS, NET ENERGY VALUES AND SPECIFIC DYNAMIC EFFECTS

A FACT that is not infrequently lost sight of in contemporary nutritional research¹ is that the utilization of any food nutrient for any purpose in the animal body requires the simultaneous presence of all other nutrients required for that purpose. And for the most complete sustained utilization of any food nutrient, the proportions in the diet of it and all other required nutrients must attain or exceed certain minimum values. For example, an adult man may require 40 grams of protein daily, although, consuming only this, he will not be able to establish nitrogen equilibrium. If his energy requirements are simultaneously covered, he may be able to establish nitrogen equilibrium, but there is no reason to expect that he could prevent losses of nitrogen from his body indefinitely

¹ For example, vitamin units are commonly defined as amounts that will produce certain more or less well-defined physiological effects. In these definitions no reference is made to the simultaneous necessity of other nutritive factors, and in the methods used for vitamin assay no provision is made to assure adequate, or even constant, intakes of other nutrients.

unless his daily diet contains also at least certain minimum proportions of each nutrient, inorganic as well as organic, that is required for all the animal functions essential to the maintenance of life. He is then receiving what may be called a "balanced diet" for adult maintenance. It is of course well known that diets may be unbalanced by including in them excessive proportions of some nutrients, such as protein or vitamin D, but this is a phase of the problem about which little definitely can be said.

For the growing animal we have a similar conception of a balanced diet, and in this case there is available much more information concerning nutrient requirements, for in the science of nutrition, as in the medical sciences, the adolescent animal has received much more attention than has the adult.

It is reasonable to assume that the balanced or unbalanced character of a diet for growth will be reflected in the efficiency with which that diet promotes growth. The completely balanced diet will promote growth the most efficiently, in the sense that, when compared with any less completely balanced diet

in properly controlled feeding experiments, a greater rate of growth will be secured on the same amount of food. This is the principle underlying the Armsby "paired feeding" method, the most precise method that has yet been proposed for effecting ration comparisons. In this method, animals are paired on the basis of sex, parentage, weight and any other measurement (such as blood hemoglobin) that may be pertinent to the problem at hand, and the pair mates are then fed the same amount of the two rations to be compared, one to one animal and one to the other. Under these conditions the better balanced of the two rations will promote the more rapid growth, or in other ways induce a better nutritive condition, for example with reference to the blood or the bones; and conversely every improvement in a diet with respect to its power to promote growth and nutritive condition is *prima facie* evidence of a betterment in its balance. The reality of this conclusion seems obvious, and no precise definition of balance in diet on any other basis has been proposed in so far as the writer is aware. In fact, a search of current writings and text-books has failed to reveal that the conception of nutritive balance in diets or rations has received much intensive thought. On the evidential side, the conclusion is supported by the results of numerous paired-feeding experiments, which have demonstrated the possibility of distinguishing on this basis better from poorer balanced diets with respect to protein, vitamins, sugars and inorganic salts.

Of the balanced ration, it may be said that the more of it is consumed, the better nourished will be the animal with reference to which the ration is balanced, up to the point of repletion of its requirements. It is an attractive hypothesis concerning unbalanced rations that the more of them are consumed the poorer nourished will be the animal with reference to the functions with respect to which the rations are unbalanced. To the writer the hypothesis has much rational appeal and it receives factual support from some experiments performed in the nutrition laboratory at the University of Illinois. Thus, young growing rats subsisting on a diet of milk will develop anemia, because milk is unbalanced with respect to the requirements of the hematopoietic tissues; and furthermore the more milk the animals consume daily, the more rapidly will the anemic condition develop, although in all other respects the animals are well nourished. Again, young rats placed upon a diet high in calcium, low in phosphorus and deficient in vitamin D will develop rickets, and the rate of development of this bone disease is the greater, the greater the daily consumption of the rachitogenic diet. Of much the same significance is the fact that young pigs placed upon a protein-deficient diet will grow

slowly, but with increasing intakes of food will become increasingly fat, representing a misdirected or uncoordinated growth. Probably further illustrations of the hypothesis that unbalanced rations, like toxic substances, exert harmful effects in proportion to the amounts consumed, will be forthcoming when it is subjected to systematic and quantitative study. The quite general failure of animals to consume unbalanced rations as avidly as balanced rations is understandable if the former may be considered physiologically harmful.

Some of the implications of the above conceptions of nutritive balance in diet are interesting and of importance to the science of nutrition. Attention will be restricted to the question of the utilization of the chemical energy contained in a diet, representing a nutritive summation of all the organic nutrients.

There is current in animal nutrition a method of assessing the energy value of rations that is far in advance of any method used in human nutrition. According to this method, introduced by Armsby some thirty years ago, the final value of a ration as a source of energy in metabolism is obtained by deducting from its gross energy (heat of combustion) all the losses of energy incident to its utilization. The metabolizable energy is the gross energy minus indigestible energy (gross energy of feces and intestinal gases) and unoxidized energy (gross energy of urine). The final, or net energy value, is equal to the metabolizable energy minus the increase in the heat production incident to the consumption and utilization of the ration. This latter increment consists largely (in farm animals) or entirely (in humans) of the "specific dynamic effect" of food. The net energy of a unit weight of a ration, expressed as a percentage of the contained metabolizable energy, measures the net availability of the latter.

With these definitions in mind, the first implication of the above-defined conception of nutritive balance in a ration or diet is that, except for differences in digestibility, the net energy value of all perfectly balanced rations is the same under the same conditions of feeding, or, somewhat more precisely, the net availability of the metabolizable energy of all perfectly balanced rations is maximal for any imposed conditions of feeding. When the net energy conception was developed by Armsby, it was his idea that each food material had its own fixed characteristic net energy value and that the net energy value of a ration was the weighted mean of the net energy values of the constituent foods. All his investigations at Pennsylvania State College were based upon this simple hypothesis, which was not inconsistent with any of the theories of energy utilization prevalent at that time. Forbes and his associates have been im-

pelled to depart from this hypothesis of Armsby, first, because of experimental evidence to the effect that the net energy value of a ration or feed is not constant, but depends upon the conditions of feeding, and second, because other evidence indicated that the net energy value of a ration bore no simple relation to the net energy value of the constituent foods. However, Forbes² recently announced "law of maximum normal nutritive value," although it advocates the use of completely balanced rations in determinations of net energy values, does not state nor imply that the net availability of the metabolizable energy of such rations will be maximal and identical. In fact, the statement that "an individual foodstuff expresses its normal and most characteristic nutritive value . . . only as it is a part of a ration which is qualitatively complete and quantitatively sufficient . . ." seems opposed to this deduction, which, if true, would lead one to suppose that the most characteristic nutritive value of a food would be observed only when it is fed alone. When properly balanced with other foods, its distinctive nutritive properties would be entirely submerged in a resultant optimal combination that would be no better nor worse than that of many other possible mixtures of foods. The recent developments in the net energy conception, initiated and defended by the Pennsylvania group, have tended to complicate the problem of net energy determinations and perhaps even to discourage those who have hoped to put the conception to practical use in the rationing of farm animals. But if all perfectly balanced rations exhibit the same net energy value (except for differences in digestibility) under the same conditions of feeding, then the problem is greatly simplified and the plan of its solution is clear; furthermore, the probability that the solution will be sufficiently simple to possess great practical value is enhanced.

A second important implication from the conception of a balanced diet developed above is that the specific dynamic effects of the various nutrients are not characteristic values except when they are fed to animals singly. When the nutrients are fed in combinations, the specific dynamic effects of the mixtures will be less than the weighted mean of the individual effects, and this decrease will continue as the combinations approach a perfectly balanced combination for the animal under experiment, of which the heating effect will be minimal. In this discussion, the term "specific dynamic effect" will be applied to the total excess heat developed by a given food or nutrient, and not to the so-called "peak" effect, which possesses an extremely limited significance.

² SCIENCE, 77: 306, 1933.

This is a decidedly heretical deduction. It is, however, a direct corollary of the preceding implication, since if the net availabilities of the metabolizable energy of all perfectly balanced rations are maximal and identical, then their specific dynamic effects must be minimal and identical.

Current theories attach definite heating effects to proteins, sugars, starches, fats, and even the various naturally occurring amino-acids, and teach that combination of these nutrients does not modify appreciably their characteristic effects as metabolic stimulants, but these theories fail to account for many facts in the science of nutrition. Eight years ago Carman and the author³ showed that the mere inclusion of 1 per cent. of sodium chloride in a ration predominantly made up of corn increased its growth-promoting value by from 40 to 50 per cent. in paired-feeding experiments with rats and chicks, without appreciably affecting its digestibility. Assuming reasonably that this effect could not have been the result of a depression of the basal metabolism or of the muscular activity of the experimental animals, it must have been an expression of a great increase in the net energy value of the ration and as great a depression in its specific dynamic effect. As we said at the time: "The growth data of this experiment afford a striking illustration of the fact that the utilization of food energy by growing animals may be greatly impaired by an improper balance among indispensable dietary factors." None of the current theories of the cause of the specific dynamic effect of food would seemingly account for this phenomenon.

Protein ingested alone by animals causes a marked specific dynamic effect, much greater than any other nutrient, but when incorporated into a protein-free diet, otherwise complete, it must decrease the specific dynamic effect of such a diet rather than increase it, because the combination will be more efficient in maintaining the energy balance of an adult animal or in increasing the energy balance of a growing animal. Weiss and Rapport⁴ were greatly mystified when they found that calorogenic amino-acids, administered to dogs along with proteins, failed to increase the calorogenic action of the latter. But equally mystifying from the standpoint of the current theories of the specific dynamic effects of food is the action of amino-acids in improving greatly the efficiency for growth of rations containing protein complexes deficient in those amino-acids.⁵ In all probability this increase in efficiency means a decrease in the specific dynamic effect, assuming again that the basal metabolic rate

³ Jour. Biol. Chem., 68: 165, 1926.

⁴ Jour. Biol. Chem., 60: 513, 1924.

⁵ H. H. Mitchell and D. B. Smuts, Jour. Biol. Chem., 95: 263, 1932.

and the activity of the experimental animals was not depressed by the amino-acid supplements.

Apparently the specific dynamic effects of isolated nutrients fed as such have very little if anything to do with the specific dynamic effects of mixtures of nutrients, particularly balanced mixtures. Without being able to specify the exact causes of the metabolic stimulation induced by the consumption of food, we may nevertheless conclude reasonably that its intensity is dependent primarily upon the degree of accumulation of the end-products of digestion within the tissues, which is in turn dependent for any given intake of food upon the rate of utilization of these products by the tissues. Their rate of utilization will be determined by the proportions existing among them, such that the better the balance with reference to the requirements of the animal the more rapid the rate of utilization and withdrawal from the cellular fluids. The metabolic stimulation thus occurs only when there is an excess of nutritive material in the tissues, and is to a considerable extent proportional to this excess. It is possibly a mechanism operating merely for the removal of excess food material from the body cells in the interests of physiological efficiency.

These speculations are now being investigated experimentally in the Division of Animal Nutrition of the University of Illinois.

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A COLOR TEST FOR VITAMIN C

WHEN ascorbic acid is boiled with HCl, CO₂ is given off, apparently the molecule loses water and furfural is formed. That furfural is formed in this reaction may be demonstrated by the use of the aniline, phloroglucinol and oreinol tests. The reaction with aniline, in which a pink color is produced when the acid solution, after boiling with HCl, is brought to a pH of 5 to 6 by adding aniline, is quantitative and may be used for the estimation of ascorbic acid. Pentoses, pentosans, hexoses and hexosans are interfering substances, but various procedures may be used to obviate the interference by these materials. Efforts are being made to develop a quantitative method, based upon this reaction, for the determination of ascorbic acid in plant and animal tissues.

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ITALIAN WORK ON LIVER THERAPY

IN none of the publications concerning the award of the Nobel Prize for their work on liver therapy in anemia by Dr. George W. Whipple, Drs. Minot and

Murphy, is mention made of the carefully controlled experiments on dogs and rabbits (1910-1912) carried out by Professor Alfonso Pirera,¹ of Naples, under the direction of the late Professor Pietro Francesco Castellino (1864-1933), of the University of Naples. They proved, clinically and experimentally, the value of liver, liver juice and liver extract in the treatment of anemia. They also demonstrated that liver injections increased the leucocytes, particularly the granulocytes. Liver injections are now being given in the treatment of granulopenic conditions, malignant neutropenia, or agranulocytosis.

While a student and associated with Professor Gaetano Salvioli (1853-1888) at Genoa, and working with Professor Edoardo Maragliano, Professor Castellino already recognized, at that time (1886-1892), the value of liver in the anemia of tuberculosis and spoke of liver stimulating bone marrow activity and the regeneration of blood.²

To Whipple, Minot and Murphy goes the credit for establishing, on a scientific basis, the general use of liver in the treatment of anemia. Priority for the early observation and the discovery (experimentally and clinically) of the value of liver and liver injections in the treatment of anemia should, in all fairness, go to the late Professor Castellino and his associate, Professor Alfonso Pirera.

In this connection, I may add the following references of interest:

Viola, Rondoni, Zoja, *La Ricerca Scientifica*, Roma (Consiglio Nazionale Delle Ricerche), 4: 7, 413-416, April 15, 1933.

Prof. G. Bonvicini, *Wiener Med. Wochenschrift*, 83: 43, 1219, October 21, 1933.

Rocco Jemma, *La Pediatria*, 41: 11, 1455-1456, November 1, 1933, especially page 1456, lines 7-15.

Antonio Chilla, *La Riforma Medica*, 45: 2, 12 Gennaio, 1929 (Anno VII), pages 39-41, and also comments by Professor Edoardo Maragliano, pages 41-42.

S. La Franca, *Rivista Sanitaria Siciliano*, 21: 20, 1600-1606, October 15, 1933, Palermo, especially page 1605, lines 23-49, page 1606, lines 1-2.

R. Gosio, (Rivendicazioni), *Il Policlinico* (Sezione Pratica, Roma), 36: 20, 709-712, Maggio 20, 1929.

Pietro Castellino, *Discorsi e Comunicazioni al XXXV Congresso della Soc. di Med. Int.*, Genova, ottobre, 1929; *Folia Medica* (Napoli), 16: I, 8-28, January 15, 1930, particularly pages 20, 21, 25 and 26; *Il Policlinico*, Sezione Pratica (Roma), 36: 46, 1685-1687, November 18, 1929.

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¹ Il Tommasi (*Napoli*), 7: 26, 601-617, September 20, 1912, and 7: 27, 625-636, September 30, 1912.

² Pietro Castellino, *Nuova Vita* (Torino, Roma, Societa Editrice Nazionale Di Propagande I igienica), 3: 15, December 12, 1912.

SCIENTIFIC BOOKS

GEOLOGICAL TEXT-BOOKS

Geologic Structures. By BAILEY and ROBIN WILLIS.
The McGraw-Hill Book Company. Third edition.
Pp. xviii + 544. 202 figures. \$4.00. 1934.

THE third edition of this well-known text-book in structural geology appeared in the summer of 1934. The subject-matter is essentially the same as that in the second edition, although some additions and subtractions have been made. The most conspicuous change is in the order of the chapters. The division of the book into four sections has been abandoned and in this new edition the chapters are in the following order: Problem of rock deformation, mechanical principles, stratified rocks, flexures and folds, analysis of folding, joints, description of faults, fault types and displacements, analysis of faulting, structures of igneous rocks, structures of metamorphic rocks, physiographic expression of structure, field methods, graphic methods, practical problems, fundamental facts and concepts.

The chapter on practical problems is an innovation and is a distinct addition to the book. It is well illustrated by thirty-one diagrams and contains many problems of an elementary type that the student may meet in the field. The chapter on physiographic expression of structure is an expansion of a few paragraphs in the second edition. The evidence offered by streams, erosion surfaces and differential erosion is discussed. This chapter emphasizes the fact that in active regions the structural geologist must likewise be a physiographer. The chapter on the structures of igneous rocks has also been expanded and greatly improved.

On the whole it is an excellent text both for student and professional geologist. Some portions of the book are unusually well written, actually stirring the enthusiasm of the reader. One student remarked to the reviewer: "That portion of the book convinced me more than ever that I wanted to become a geologist." The text is not too abstruse for the average student but at the same time contains plenty of meat.

Some definitions are not as lucid as they might be. Some, moreover, are actually erroneous—at least, they do not conform to best usage. The reviewer would like to call attention to them at this time, but in so doing he does not mean to imply that the book as a whole is not an excellent publication. Recumbent folds, for example, are illustrated on pages 64 and 65, with the axial planes dipping about 60°. It is customary, however, to restrict the term "recumbent" to those folds in which the axial plane is essentially horizontal. This usage has been followed by Nevin, Collet, Pirsson and Schuchert, Lahee and others.

On page 361 the statement is made that "inlier" is synonymous with "window." This is a mistake that has been made in several recent American text-books. "Window" should be restricted to those instances in which erosion has broken through an overthrust sheet or recumbent antiline to expose the underlying formation. Collet ("Structure of the Alps," p. 15) is very careful to distinguish between window and inlier.

"Upthrust" should be more carefully defined. On page 138 the statement is made: "Thus a horizontal force may act through one mass against another mass which offers more resistance. The resulting shear planes in the first are diverted upward and may outcrop at the surface as vertical faults. Such faults are called *upthrusts*." On page 152: "Cases occur in which a mountain block is tilted away from, instead of toward a great fault. The Sierra Nevada of California is an example, since it is bounded along its eastern side by a fault on which the vertical displacement is as much as 5,000 feet, while the peninsular plain that now forms the western slope is tilted away from the fault. In this and similar cases the block has plainly been rotated, with the result that one edge has been raised to a great height and the other edge has been depressed. We may say in such a case that the raised edge has been thrust up and the fault may be called an upthrust fault." Page 138 emphasizes the conversion of horizontal motion into vertical motion; page 152 says nothing of this; page 153 states that upthrusts are vertical, but figure 73 shows the Sierra Nevada faults dipping 60°. Under Fig. 77 an ordinary reverse fault is defined as an upthrust. The term *upthrust* must be more clearly defined before it can be incorporated into the geologic literature.

On page 124, the following statement appears: "Fracture, as the word is used in this book, means a rough break. It is distinguished from shear, which is a smooth break." Such a restriction in the use of the word fracture has no justification in engineering practice and nothing is to be gained by such a definition in geology.

The reviewer feels that the classification of faults adopted is far from satisfactory, but he fully appreciates the difficulties involved and would hesitate to offer a substitute. It is to be hoped that eventually geologists will have a genetic classification of faults instead of one based on angle of dip.

Despite the criticisms given above, the reviewer feels that "Geologic Structures" is an excellent presentation of the subject and is preëminent in its field.

MARLAND BILLINGS

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Historical Geology. By RAYMOND C. MOORE. ix + 673 pages, with 413 illustrations, including 52 block diagrams in 16 figures, 42 maps, 32 sections and 22 figures comprising numerous graphic representations of stratigraphic sequences. McGraw-Hill Book Company, Inc., New York. \$4.00.

THE writer of a text-book in historical geology must make a choice. An adequate presentation in word, picture, chart and map, of the basic facts, the lines of reasoning and the resulting generalizations, such as are needed for a satisfactory introduction to this phase of geology, would exceed the limits of size and cost of a salable text-book. The writer can devote his pages primarily to generalizations, counting on the lecturer to supply the needed supplementary facts, or he can place the emphasis on the actual record.

In his text-book, Dr. Moore has taken the latter course. For each period, for instance, he gives a number of typical sections showing the actual sequence of strata drawn graphically in a striking manner. He leaves it largely to the lecturer to supply correlation tables. Incidentally, the graphical method has made it possible to place into these sections a large part of the over seven hundred stratigraphic names listed separately in the index, without forcing them to the attention of the non-technical reader. This makes the book valuable as a reference work without harming its appeal as a text-book.

Similarly, he presents maps showing the areas of outcrop and of inferred original distribution for the rocks of every system, but omits hypothetical paleogeographic maps. Such maps are most effective when

developed by the lecturer on a blackboard map from the data presented in the book.

Throughout the text, emphasis is placed on the facts of observation and on the reasoning employed in the attempt to correlate them and weld them into a consistent picture, in conscious opposition to the tendency evident in text-books of all sciences to tell the student what "science teaches."

Of the several masterly text-books that are now available in historical geology, Moore's book goes farthest in this effort to cultivate the spirit of critical judgment in inductive reasoning.

On the biologic side, Moore departs from traditional methods by figuring a number of fossils of one taxonomic group on one plate, all drawn to a specified scale. There can be no doubt that this method comes nearer creating adequate mental pictures than the customary one of figuring for each period on one plate random samples of animal forms of diverse groups, generally drawn on vastly different scales. In order to make possible such effective grouping, the forms of life are not discussed separately for every period, but only in four chapters, one devoted to each of the following major units; Early Paleozoic, Late Paleozoic, Mesozoic and Cenozoic time. A brief but effective chapter on the geologic history of man ends the book.

Among the other illustrations effective use is made of block diagrams. The quality of some of the half-tones is subject to criticism, but their selection is excellent.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A DEVICE FOR WATER CIRCULATION

A SIMPLE air pump can be easily constructed which will maintain a continuous circulation of clean aerated fresh or salt water through an aquarium. The pump (fig. 1) is made from a pyrex glass test-tube, the height of which is 10 cm and the inside diameter is 5 cm. A pyrex glass tube (a.) with an inside diameter of 5 mm is sealed to the side of the test-tube approximately 2 cm from the mouth and then bent so that the glass tube is parallel with the test-tube. A similar glass tube (b.) is sealed to the base of the test-tube. The pump is placed in an inverted position with the reservoir and an exceedingly small air current is permitted to enter the pump through the glass tube (a.) at the side. The exact depth at which the pump will give a maximum efficiency may be determined by experimentation; however, the pump should

be at least 15 cm below the water level in the reservoir. The air upon entering the pump entrains a small column of water which it pushes out the supply pipe (b.) in the manner of a percolator. The amount of air current may be adjusted to give an optimum flow. Although the pump can force the water a distance of some five feet above the reservoir, it works more efficiently if the aquarium (aq.) is placed at a lower level.

The supply pipe (b.) may be led directly to the aquarium (aq.) or first to a Wolff bottle (bo.) which merely serves to maintain an even flow into the aquarium itself. Leading from the aquarium is an automatic siphon (s.) which keeps the water level at a constant height. The overflow through the automatic siphon is carried into the top of the filter (f.). This consists of a glass cylinder filled for the lower

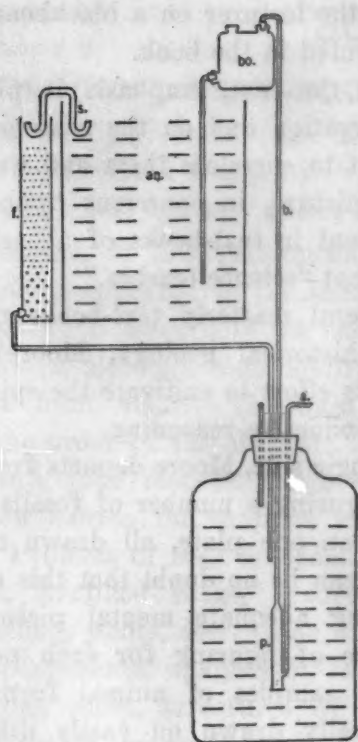


FIG. 1

third with gravel and for the remaining upper two thirds with fine sand. The water filters slowly downward, leaves by way of a glass tube and returns to the reservoir.

The cork stopper of the reservoir should contain four openings: one for the tube returning water from the filter, one for the supply pipe (b.) conveying water to the aquarium, one for the air tube (a.) and one to equalize the air pressure within the reservoir. A cover may be placed over the top of the aquarium to prevent excessive evaporation, especially if the system is for sea water.

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IMPROVEMENT OF PARAFFIN SECTIONS BY IMMERSION OF EMBEDDED TISSUES IN WATER

IN a recent article in *SCIENCE*, Slifer and King¹ suggested a modification of Petrunkevitch's² technique for softening tissues too brittle for sectioning by the paraffin method. The work of these investigators was carried out on grasshopper eggs and entailed the use of a 4 per cent. solution of phenol in 80 per cent. alcohol and subsequent soaking of the embedded tissues in water. Either of these two processes without the other failed to give satisfactory results.

Difficulties encountered for several years in this laboratory in the sectioning of rats' adrenals led to the investigation of the applicability of the technique

described by Slifer and King to adrenal and other tissues. The adrenal glands used in our studies had to be treated by special methods. The glands were fixed in Wislocki's³ modification of Kohn's fluid containing potassium dichromate and formalin, washed in formalin, and passed through graded solutions of alcohol to 70 per cent. The adrenals were then bleached in hydrogen peroxide and alcohol for several hours. This part of the process frequently rendered the glands extremely brittle. They were next passed through graded solutions of alcohol to absolute alcohol and cleared in a mixture of benzyl benzoate and methyl salicylate. The brittleness of the adrenals increased in proportion to the time the glands remained in the mixture. Some which were left in this fluid for two years or more crumbled when they were sectioned.

In view of these difficulties it seemed advisable to utilize the Slifer and King method in our work. In the case of the adrenals, the glands were exposed to a 4 per cent solution of phenol before or after bleaching in hydrogen peroxide or clearing in the oil mixture. As it would have been impractical to cut the adrenals in half, since the obtaining of serial sections for reconstructions was desired, surfaces of the glands were not exposed to water. It was hoped that the phenol treatment alone would suffice to soften the embedded material. The glands failed to section, but it was observed that if water was applied to the surface of the block before each section was cut, that section came off perfectly. This same effect, however, occurred even though the glands had not been previously treated with phenol. It seemed reasonably certain that if a surface of the embedded glands could be exposed to water, the laborious necessity of moistening the block for each section could be eliminated. The crux of this problem lay in the fact that exposure of a large surface would entail the loss of important sections.

The following method afforded a solution to the problem. Rats' adrenals were prepared by the technique outlined above. These included fresh material and material which had been preserved in the clearing mixture for several years. None of the glands was treated with phenol at any time in the course of preparation. After the glands were embedded in paraffin was shaved off in such a way that one surface of each gland was just scratched. Whatever section would be lost by this procedure could be accounted negligible for accurate reconstructions. Each block was then immersed in water and allowed to soak for varying periods of time. When the allotted time period for each block had elapsed, the

¹ Eleanor H. Slifer and R. L. King, *SCIENCE*, 78: 366, 1933.

² A. Petrunkevitch, *SCIENCE*, 77: 117, 1933.

³ G. B. Wislocki, *Bull. Johns Hopkins Hosp.*, 33: 35, 1922.

exposed surface was carefully dried and dipped into melted paraffin. Care had to be exercised in this manipulation to avoid stratification and formation of bubbles between the hot and cold layers of paraffin. The block was cooled and trimmed as usual. Glands which had been soaked for a sufficiently long time sectioned perfectly, and the ribbon was flawless. The minimum length of time required for the water treatment varied between three days and two weeks, depending upon the size of the gland. Soaking for longer periods was not harmful to the tissues.

This method did not in the least impair the staining properties of the sections nor did it affect the histologic aspect of the tissues. Actual quantitative studies involving reconstructions proved the loss of tissue was so slight as to be insignificant.

The results of the work with the adrenals were so encouraging that our studies were extended to other tissues which, although prepared by ordinary histologic methods for sectioning, presented similar difficulties. Several blocks of spleen which previously it had been impossible to section were subjected to the water treatment. Quite satisfactory sections were then obtained from this material. Sections of human autopsy material, including intestine, ovary, liver, kidney and stomach, were noticeably improved. In Table 1 are listed the various types of tissues tested in this study. The results in every case were distinctly satisfactory.

An interesting feature was the absence of electrification of sections. It was noted that bone tissue, not

TABLE 1

Tissue	Animal	Fixative	Number of specimens
Adrenals	Rat	Wislocki	50
Intestine	Human (autopsy)	Zenker	3
Stomach	Human (autopsy)	Zenker	2
Liver	Human (autopsy)	Zenker	1
Ovary	Human (autopsy)	Zenker	1
Kidney	Human (autopsy)	Zenker	1
Kidney	Kitten	Bouin	3
Basisphenoid	Rat	Bouin	50
Hypophysis	Rat	Bouin	10
Muscle	Kitten	Bouin	2
Tongue	Kitten	Bouin	2
Spleen	Rat	Bouin	2

materially softened by water, sectioned much more satisfactorily after water treatment, by virtue of the elimination of static charge.

It is conclusively shown by this series of investigations on various types of mammalian tissues that exposure to water of a small area of embedded material will obviate (1) difficulties consequent to brittleness, and (2) electrification of sections.

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SPECIAL ARTICLES

MONOCYTES AS AN INDICATOR OF CERTAIN STATES OF BLOOD SERUM

It is already known that cell colonies can be used for detecting certain characteristics of blood serum. The mode of activity of living tissues depends in a large measure on the nature of their medium. Any anatomical structure consists of humors as well as of cells. The morphology of the cells is almost meaningless, if not related to the chemical constitution of the humors. Conversely, the composition and the physicochemical conditions of an organic fluid remain without great significance unless expressed in terms of their structural and functional effects. For instance, the transformation of blood monocytes into cells closely resembling macrophages, clasmotocytes, epithelioid cells and fibroblasts is indicative of the presence around the cells of definite media. Likewise, the serum of old, starved or sick animals is characterized by its retarding or accelerating effects on the growth of colonies of fibroblasts. Fibroblasts have often been used as an indicator of the state of the

humors.¹ The value of the growth index of a given serum depends on ill-defined chemical changes undergone by an animal under the influence of physiological or pathological agencies. In old age or in animals having an abscess, the growth index becomes low.² It generally rises during starvation or in certain infections. In experimental tuberculosis, as Swift has shown,³ the serum is growth-inhibiting at the beginning of the disease and growth-stimulating during the period of leucocytosis.

The colonies of fibroblasts react against the variations of blood serum by changes in their rate of growth. But they are not very sensitive to those variations, much less so than blood monocytes are.

¹ A. Carrel and A. H. Ebeling, *Jour. Exp. Med.*, 34: 599, 1921; 38: 419, 1923. L. E. Baker and A. Carrel, *Jour. Exp. Med.*, 45: 305, 1927.

² A. Carrel and A. H. Ebeling, *Compt. rend. Soc. biol.*, 90: 170, 1924. A. Carrel, *Compt. rend. Soc. biol.*, 90: 333, 1005, 1924.

³ H. F. Swift, J. K. Moen and E. Vaubel, *Jour. Exp. Med.*, 60: 149, 1934.

Colonies of monocytes have recently been found to be a better detector of certain conditions of serum than fibroblasts. We know that the rate of migration and multiplication *in vitro* of leucocytes is markedly modified by a great many substances. Moreover, their morphological appearance may change in an enormous number of ways. A monocyte readily modifies its size, shape, nucleus, neutral red vacuoles, fat granules, mitochondria, number of nuclei, undulating membrane and mode of association with other cells. As all these characters may undergo several variations, the number of the permutations of these variations is extremely large, and each monocyte and colony of monocytes is capable of having its individual aspect.

The morphological study of monocytes cultivated in fluid and gaseous media of known composition has been rendered easy by a simple technical progress. The flasks described as microflasks have lately been very much improved. The thickness of the wall is now less than 0.1 mm. Therefore, blood monocytes can be studied at a magnification of 1,000 or 1,500 diameters, while having at their disposal a large amount of nutritive fluid and gases. The leucocytes of an animal are cultivated in their own serum and in the serum of a normal or diseased animal of the same breed. The leucocytes of this second animal are also cultivated in their own serum and in the serum of the first animal. After five or six days, the cells respond to their medium by taking on an aspect that varies almost with each serum. The experiments have been made on chickens, dogs, guinea-pigs and cats. In practically every experiment, the cells acted in an identical manner. When the monocytes of an individual were grown in the serum of another individual, they assumed the appearance of the monocytes of this second individual grown in their own serum. This fact indicates that the appearance of monocytes in their own serum is a transitory character and expresses merely a certain condition of the serum. The same phenomenon occurs in a still more striking manner when the second animal is suffering from an abnormal or pathological state, such as starvation, anemia, immunization, eczema, cancer, etc. For instance, the blood monocytes of chickens inoculated in the breast with a Rous sarcoma become rounder and coarser and agglutinate in clumps when cultivated in their own serum. If placed in the serum of a normal chicken, they tend to lose their pathological character and to resemble the monocytes of this chicken. Conversely, the monocytes of the normal chicken, cultivated in the serum of the sarcomatous chicken, after a few days more or less closely resemble the monocytes of that chicken. A similar phenomenon was observed in other diseases. But the changes imposed on serum by the disease generally respect some individual char-

acteristics. Very seldom does the blood serum of two normal chickens of the same breed, Plymouth Rock or Rhode Island Red, for instance, give an identical appearance to two cultures of the same monocytes. It is obvious that these cells are a very delicate indicator of the conditions of their medium. To summarize:

(1) The structure of blood monocytes and their mode of association depend, in a large measure, on certain qualities of blood serum.

(2) Monocytes from different sources tend to take on the same appearance in a given serum. Each serum imposes upon monocytes a definite character. Pathological monocytes become like normal monocytes in the serum of the latter. And normal monocytes assume the aspect of pathological leucocytes when cultivated in the pathological serum.

(3) The aspect of monocytes cultivated in a given serum expresses simultaneously the individual characteristics of this serum and the modifications of those characteristics under the influence of pathological agencies.

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TEMPORARY PREVENTION BY CHEMICAL MEANS OF INTRANASAL INFECTION OF MICE WITH EQUINE ENCEPHALOMY- ELITIS VIRUS

IN a recent report in *SCIENCE*¹ we described a method for active immunization of guinea pigs against experimental equine encephalomyelitis, by means of subcutaneous injections of virus adsorbed on aluminum hydroxide. Mention was made of the production by the alumina gel-virus of local indurations lasting several weeks. It was later found that in the guinea pig 0.2 per cent. tannic acid² (tannin) could be substituted for the aluminum compound with no increase in pathogenicity, nor decrease in immunizing power of the virus, and moreover, with no production of cutaneous induration. These methods of immunization depend, however, on the action of living although, as used here, non-infective virus. In another article all the experiments including those relating to poliomyelitis will be described in detail.

During the course of this study, tannic acid alone was dropped into the nose of white mice. We found that this simple act induced resistance against the effects of intranasal instillation of eastern and western strains of the encephalomyelitis virus, a procedure ordinarily lethal in normal animals.

For example, 0.05 cc of 0.5 or 1 per cent. tannic

¹ H. R. Cox and P. K. Olitsky, *SCIENCE*, 79: 459, 1934.

² Mallinckrodt's Acid Tannic, Analytical Reagent.

acid³ in distilled water was dropped into the noses of 114 mice, three times a day for three successive days, and 0.05 cc of 1:250 dilution of virus-infected mouse brain, or at least 1,000 minimal lethal doses, on the fourth day. Only six of the mice succumbed to experimental encephalomyelitis; whereas of 153 untreated, control animals that received the same virus at the same time, 142 died. The results are more remarkable when considered in contrast with the general ineffectiveness, in 76 mice, of other substances substituted for tannic acid. They include normal saline solution, normal and antiviral rabbit serum, merthiolate (1:5000), hexylresorcinol (in S. T. 37, 1:3), ephedrine (1:100), and formalin (1:50). The formalin was administered to induce especially increased nasal secretion; it is noteworthy that the excessive mucoid discharge so produced did not hinder local infection with the virus. On the contrary, the tannic acid solution caused no grossly visible damage to the nasal mucosa.⁴

The chemical effects of the acid on tissue, as they are now known, are dehydration, precipitation of the soluble proteins of superficial cells and secretions and combination of all proteins with it to form a material which, among other properties, shows a greater degree of resistance to the destructive action of ordinary bacteria and enzymes.^{4, 5, 6, 7} Histological studies of nasal membranes of tannin-treated mice reveal either no effect or slight shrinkage of the lining cells, accompanied by a deposition of more or less uniform precipitated material covering the ciliary surfaces. The open nasal spaces contain a slightly increased cellular exudate. By following the method of Clark,⁸ who reported the transit, within 3 hours, of Prussian blue particles from the nasal cavity to the brain of the rabbit, by way of the olfactory nerve, we found that in normal mice there occurred within this time a generalized dispersion of the dye throughout the epithelium and invasion of the nerve by finer blue

granules. In tannin-treated animals, however, the dye was less evident in the epithelial layers and not visible in the olfactory rootlets and nerve.

The preventive action of tannic acid is exerted locally: Tannin-treated mice are as susceptible to lethal infection after cerebral inoculation of virus as are normal animals. Another point showing that a barrier, as it were, may be set up against the infectious agent at a portal of its entry is that virus, if dropped into the nose first and tannin later, even in so short a time as 15 minutes, loses none of its activity.

It appears, besides, that a sufficient amount of tannic acid is necessary to insure its action in warding off virus infection. The method as described above was shown to yield protection in 94.7 per cent. of the treated mice, but when 0.25 instead of 0.5 or 1 per cent. of the chemical was employed, resistance was induced in 75 per cent. of the animals. Again, when the acid was administered in the usual dose of 0.5 or 1 per cent. but instilled on one or two, instead of three successive days, 39 and 62 per cent., respectively, of 23 mice in each instance, were found to resist the virus given intranasally on the day following the last instillation of the chemical.

The duration of protection afforded by tannin is, however, transient; the nasal passages approach their normal condition of sensitiveness to virus infection on the eleventh day after the beginning of the tannic acid instillations. Thus, when virus was dropped into the nose of mice on the fourth day, 94.7 per cent. of the animals were protected; on the fifth, 87.5; sixth, 83; seventh, 58.8; eighth, 30 per cent. and on the ninth and tenth days, only an occasional mouse was found to be refractory to infection. Thereafter all tannin-treated mice were normally reactive to the virus. Nevertheless, experimental results indicate that the treatment can be repeated in the same animal so as to bring about a similar temporary virus-resistant state.

To conclude, it has been found possible to induce a transient resistance in mice to intranasal infection with two strains of equine encephalomyelitis virus by prior applications of tannic acid to the nasal mucosa.

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X-RAY DIFFRACTION STUDIES ON NERVE

ANALYSIS of x-ray diffraction photographs of nerve made by us during the past few months indicates what appears to be a fundamental similarity between the fine structure of the axis cylinder of nerve and that of other animal fibers, such as hair, tendon and

³ An unknown quantity is lost at each instillation through insufficient sniffing by the mouse, for the method consists in depositing the fluid employed drop by drop at the nasal orifices by means of a 27 gauge needle. The animal then inhales the material, requiring 2 minutes for the procedure. By this method injury to the nasal mucosa is avoided. However, for reasons as yet unknown, the same technique, when applied to guinea pigs, has thus far failed to protect these animals against intranasal infection with the same virus.

⁴ For the innocuousness of tannic acid, especially in the amounts given, see W. A. Bastedo, "Materia Medica," W. B. Saunders Co., Philadelphia, 1933, 3rd edit.

⁵ H. P. Krut, "Colloids," John Wiley and Sons, New York, 1930.

⁶ H. Gnam, "Die Gerbstoffe und Gerbmittel," Wiss. Verlag, M.B.H., Stuttgart, 1933.

⁷ M. Bergmann, personal communication.

⁸ W. E. Le G. Clark, "Reports on Public Health and Medical Subjects," Ministry of Health, London, 1929, 1-27.

muscle. In this preliminary note we wish to describe briefly the most prominent features of these photographs and their probable interpretation in terms of nerve structure. A detailed report will appear in another place.

For this work the $K\alpha$ radiation of copper was used, the average exposure time being ten minutes. While the patterns are not as sharp as those from more perfectly oriented structures, such as hair and tendon, the spacings are clear enough to permit fairly satisfactory measurement. In fresh sciatics the following spacings are distinguishable: an equatorial point at 40–45 Å and another at 14–17 Å, a ring at 4.6–4.8 Å, with clearly defined meridional sickles, and an outer ill-defined ring at 2.8–3.1 Å. The inner equatorial point very close to the central spot can be observed only by careful centering of the primary beam and by using very small pinholes and beads. This pattern seems to be typical for fresh medullated nerve, since it has been obtained from the sciatic, motor and sensory roots and spinal cord of the frog and cat. The smaller equatorial spacing decreases with drying to 11–12 Å. Tension tends to sharpen the picture somewhat, but, as in the case of muscle, produces no new pattern.

Because of its similarity to the diagram of α -keratin it seems likely that the molecular configuration producing the diagram in nerve corresponds to a system of oriented protein primary valence chains lying parallel to the fiber axis. The equatorial spacing of 17 Å corresponds to the direction of the side chain rungs (0, 0, 1 spacing of Astbury and Street¹) and the meridional spacing probably corresponds to the reflection from double amino-acids residues along the fiber axis. A large equatorial spacing has been observed in keratin diagrams, but its significance is uncertain.¹ We have entertained the view that this spacing in nerve and perhaps also in other animal fibers may correspond to the lateral distance between micelles. Since it is almost completely absent in pictures from nerves subjected to long soaking in alcohol, it is conceivable that this lateral distance is maintained by lipid or other fatty molecules acting as lateral spacers and oriented perpendicularly to the long axis of the micelles. Since the 4.6 Å spacing shows relatively imperfect fibering and the side chain spacing tends to appear as elongated points there must be considerable random orientation of primary valence chains. Intermicellar protein chains are also evidenced by the diffuse ring at 3.1 Å.

Boehm,² who also observed the 17 Å equatorial and the 4.8 Å meridional spacings, attributed the former

¹ W. T. Astbury and A. Street, *Phil. Trans. Roy. Soc. A*, 230: 75, 932; *ibid.*, 232: 333, 1933.

² G. Boehm, *Koll. Zeitschr.*, 62: 22, 1932.

to connective tissue micelles and the latter to radially oriented fluid crystals of the myelin sheath. Axis cylinder, according to him, produces no pattern. However, we find no correlation between the presence of connective tissue and the 17 Å spacing; this spacing has been observed not only in sciatic nerve but also in corpus callosum, spinal cord, motor and sensory roots, and also in lobster and crab nerves. We have, moreover, observed a spacing of 4.8–5.0 Å in lobster nerve, and in a few instances, meridional sickles at 2.5 Å, which are presumably second order reflections. There can be no doubt that the primary valence chains in lobster and crab claw nerves are very highly solvated and exist for the greater part, in the fresh tissues, as unoriented chains. The fresh nerve usually shows only one or two very diffuse rings. But by careful drying under tension, or better by very slow dehydration with increasing concentrations of alcohol up to absolute, a very clear equatorial spacing appears at 11–14 Å, and second order meridional sickles are often visible at 2.4–2.5 Å. From these considerations it seems more reasonable to believe that the pattern observed with nerve is essentially that of a single system of partially oriented primary valence chains probably admixed with unoriented intermicellar protein chains. Histological evidence seems fairly conclusive that the site of this fibrous structure is the axis cylinder. This explanation fits well with data of thermal shortening and on solvation and desolvation of nerve.³ Since the radiation required to produce these patterns has no appreciable effect on the irritability of the nerves and if further analysis of the pictures confirms the view given above this constitutes the first evidence for the existence of a typically fibrous condition in the axis cylinder of a "normal" nerve. Moreover, a means is now available for a direct attack upon the problem of the rôle of axis cylinder proteins in nerve phenomena.

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³ F. O. Schmitt and L. J. Wade, *Am. Jour. Phys.* 109: 93, 1934. Final papers in press.

BOOKS RECEIVED

FINLAY, MARGARET C. *Our American Maples and Others*. Pp. 19 + 43 plates. Georgian Press, New York.
HESS, JULIUS H., GEORGE J. MOHR and PHYLLIS BARTELME. *The Physical and Mental Growth of Maturely Born Children*. Pp. xxiii + 449. 89 figures. University of Chicago Press. \$5.00.